

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:)
Harue Nakashima et al.)
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For: LIGHT EMITTING ELEMENT, LIGHT)
EMITTING DEVICE, AND ELECTRONIC DEVICE)

VERIFICATION OF TRANSLATION

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Sir:

I, Chihiro FUKUSHIMA, C/O Semiconductor Energy Laboratory Co., Ltd. 398, Hase, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

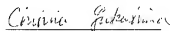
that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the Japanese Patent Application No. 2004-347903 filed on November 30, 2004; and

that to the best of my knowledge and belief the following is a true and correct translation of the Japanese Patent Application No. 2004-347903 filed on November 30, 2004.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 22 day of June



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[List of Attachment]

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[Document Name] Scope of Claim

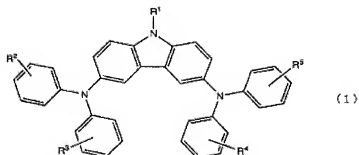
[Claim 1]

A light emitting element characterized by including:

- 5 a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode,

in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1).

10 [Chemical Formula 1]



[Claim 2]

A light emitting element characterized by including:

- 15 a plurality of layers between a first electrode and a second electrode, in which the plurality of layers includes a layer containing a light emitting substance and at least one layer having a function of generating holes, and

in which the layer having a function of generating holes contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to a carbazole derivative represented by General

20 Formula (1).

[Claim 3]

A light emitting element characterized by including:

a plurality of layers between a first electrode and a second electrode,

- 25 in which the plurality of layers includes a layer containing a light emitting substance and at least one layer having a function of transporting holes,

in which the layer having a function of transporting holes contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to a carbazole derivative represented by General Formula (1).

5 [Claim 4]

A light emitting element characterized by including:

a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode,

10 in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1),

15 in which a layer containing the carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the first electrode, and

in which an element structure is such that light is emitted when a voltage is applied so that a potential of the first electrode is higher than a potential of the second electrode.

20 [Claim 5]

A light emitting element characterized by including:

a plurality of layers including a layer containing a light emitting substance between a first electrode and a second electrode,

25 in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1),

30 in which a layer containing the carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the second electrode, and

in which an element structure is such that light is emitted when a voltage is

applied so that a potential of the first electrode is higher than a potential of the second electrode.

[Claim 6]

A light emitting element characterized by including:

5 a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode,

in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General

10 Formula (1),

in which a layer containing the carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the first electrode, and between the layer

15 containing a light emitting substance and the second electrode, and

in which an element structure is such that light is emitted when a voltage is applied so that a potential of the first electrode is higher than a potential of the second electrode.

[Claim 7]

20 A light emitting element characterized by including:

a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode,

in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a metal oxide.

25 [Claim 8]

A light emitting element characterized by including:

a plurality of layers between a first electrode and a second electrode,

in which the plurality of layers includes a layer containing a light emitting substance and at least one layer having a function of generating holes, and

30 in which the layer having a function of generating holes contains a carbazole derivative represented by General Formula (1) and a metal oxide.

[Claim 9]

A light emitting element characterized by including:
a plurality of layers between a first electrode and a second electrode,
in which the plurality of layers includes a layer containing a light emitting
substance and at least one layer having a function of transporting holes, and
5 in which the layer having a function of transporting holes contains a carbazole
derivative represented by General Formula (1) and a metal oxide.

[Claim 10]

A light emitting element characterized by including:
a plurality of layers which includes a layer containing a light emitting
10 substance between a first electrode and a second electrode,
in which at least one layer of the plurality of layers contains a carbazole
derivative represented by General Formula (1) and a metal oxide,
in which the layer containing a carbazole derivative represented by General
Formula (1) and a metal oxide is provided between the layer containing a light emitting
15 substance and the first electrode, and
in which an element structure is such that light is emitted when a voltage is
applied so that a potential of the first electrode is higher than a potential of the second
electrode.

[Claim 11]

A light emitting element characterized by including:
a plurality of layers which includes a layer containing a light emitting
substance between a first electrode and a second electrode,
in which at least one layer of the plurality of layers contains a carbazole
derivative represented by General Formula (1) and a metal oxide,
25 in which the layer containing a carbazole derivative represented by General
Formula (1) and a metal oxide is provided between the layer containing a light emitting
substance and the second electrode, and
in which an element structure is such that light is emitted when a voltage is
applied so that a potential of the first electrode is higher than a potential of the second
30 electrode.

[Claim 12]

A light emitting element characterized by including:

a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode,

in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a metal oxide,

5 in which the layer containing a carbazole derivative represented by General Formula (1) and a metal oxide is provided between the layer containing a light emitting substance and the first electrode, and between the layer containing a light emitting substance and the second electrode, and

10 in which an element structure is such that light is emitted when a voltage is applied so that a potential of the first electrode is higher than a potential of the second electrode.

[Claim 13]

A light emitting element according to claims 7 to 12, characterized in that the metal oxide is one or a plurality selected from any transition metal oxide of Group 4 ~ Group 12 in the periodic table.

[Claim 14]

A light emitting element according to claims 7 to 12, characterized in that the metal oxide is one or a plurality selected from any transition metal oxide of Group 4 ~ Group 8 in the periodic table.

20 [Claim 15]

A light emitting element according to claims 7 to 12, characterized in that the metal oxide is one or a plurality selected from molybdenum oxide (MoO_x), vanadium oxide (VO_x), ruthenium oxide (RuO_x), tungsten oxide (WO_x), rhenium oxide (ReO_x), titanium oxide (TiO_x), chromium oxide (CrO_x), zirconium oxide (ZrO_x), hafnium oxide (HfO_x), tantalum oxide (TaO_x).

[Claim 16]

A light emitting device characterized by using a light emitting element according to any one of claims 1 to 15 as a pixel or a light source.

[Claim 17]

30 An electronic device characterized by using a light emitting device according to claim 16.

[Document Name] Specification

[Title of the Invention] LIGHT EMITTING ELEMENT, LIGHT EMITTING DEVICE, AND ELECTRONIC DEVICE

[Technical Field]

5 [0001]

The present invention relates to a light emitting element having a structure in which a plurality of layers is interposed between a pair of electrodes, and especially relates to a structure of a layer which can be used as at least one layer of the plurality of layers.

10 [Conventional Art]

[0002]

A light emitting device utilizing light emission from an electroluminescence element (light emitting element) attracts attention as a device for displaying or for lighting.

15 [0003]

As the light emitting element used in the light emitting device, one having a structure in which a layer containing a luminescent compound is interposed between a pair of electrodes is well known.

[0004]

20 In such a light emitting element, one electrode and the other electrode respectively function as an anode and a cathode. Holes injected from the anode side and electrons injected from the cathode side are recombined to form excited state molecules, and when they return to a ground state, they emit light.

[0005]

25 By the way, the reduction of power consumption is highly required especially in a display device for being incorporated in various information-processing devices which has been rapidly developed in recent years. In order to achieve this, the reduction of driving voltage of the light emitting element is being attempted. In addition, in consideration of commercialization, the increase of the lifetime of the light
30 emitting element is important as well as the reduction of the driving voltage, and in order to achieve this, the light emitting element is being developed.

[0006]

For example, in Patent Document 1, a technique of reducing driving voltage of a light emitting element by using metal oxide having a high work function such as molybdenum oxide as an anode is disclosed. In addition, with this technique disclosed in Patent Document 1, an effect of increasing lifetime can be obtained.

5 [0007]

However, since molybdenum oxide is easy to be crystallized, malfunctions of the light emitting element due to the crystallization cannot be reduced sufficiently. In other words, since molybdenum oxide is crystallized to form a projection portion and loses flatness, a short circuit easily occurs and there has been a problem of easily causing malfunctions of the light emitting element.

10

[Patent Document 1] Japanese Patent Laid-Open No. H9-63771

[Disclosure of Invention]

[Problems to be Solved by the Invention]

[0008]

15 It is an object of the present invention to provide a light emitting element which can reduce malfunctions due to oxidation or crystallization of a compound.

In addition, it is an object of the present invention to provide a light emitting element which has a low driving voltage and which can increase lifetime longer than a conventional light emitting element.

20 [Means for Solving the Problems]

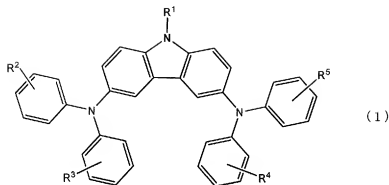
[0009]

The light emitting element of the present invention is characterized by including a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode, in which at least one layer of the plurality of layers contains a compound having a carbazole skeleton represented by following General Formula (1) (carbazole derivative) and a substance having an electron accepting property with respect to the carbazole derivative represented by following General Formula (1).

25

[0010]

30 [Chemical Formula 1]



(in the formula, R₁ refers to hydrogen, a halogen, a cyano group, an alkyl group having a carbon number of 1 ~ 20, a haloalkyl group having a carbon number of 1 ~ 20, an alkoxy group having a carbon number of 1 ~ 20, a substituted or unsubstituted aryl group, a substituted or unsubstituted heterocycle residue, and R₂ ~ R₅ may each be the same or different and refer to hydrogen, a halogen, a cyano group, an alkyl group having a carbon number of 1 ~ 20, an alkoxy group having a carbon number of 1 ~ 20, an acyl group having a carbon number of 1 ~ 20, a haloalkyl group having a carbon number of 1 ~ 20, a dialkylamino group having a carbon number of 1 ~ 20, a diarylamino group having a carbon number of 1 ~ 20, a substituted or unsubstituted heterocycle residue, a carbazolyl group.)

[0011]

With the above structure, that is, the coexistence of the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) in one layer, even before voltage is applied to the light emitting element, the carbazole derivative represented by General Formula (1) are deprived of electrons by the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1). In other words, the carbazole derivative represented by General Formula (1) is oxidized and generates holes.

[0012]

Therefore, "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with

respect to the carbazole derivative represented by General Formula (1)" has a function of generating holes.

[0013]

Therefore, the light emitting element of the present invention is characterized
5 by

including a plurality of layers between a first electrode and a second electrode,
in which the plurality of layers includes a layer containing a light emitting
substance and at least one layer having a function of generating holes, and

the layer having a function of generating holes contains the carbazole
10 derivative represented by General Formula (1) and the substance having an electron
accepting property with respect to the carbazole derivative represented by General
Formula (1).

[0014]

And, since holes can be generated in "the layer containing the carbazole
15 derivative represented by General Formula (1) and the substance having an electron
accepting property with respect to the carbazole derivative represented by General
Formula (1)" by providing "the layer containing the carbazole derivative represented by
General Formula (1) and the substance having an electron accepting property with
respect to the carbazole derivative represented by General Formula (1)", a conductive
20 film having a high work function and a conductive film having a low work function can
be used as a material contained in the first or second electrode.

[0015]

In other words, in a conventional light emitting element, the conductive film
having a high work function was used as an anode in order to inject holes into a layer
25 containing a light emitting substance from the anode. However, in the present
invention, since the layer having a function of generating holes exists, the conductive
film having a high work function does not need to be used as the anode.

[0016]

And, since "the layer containing the carbazole derivative represented by
30 General Formula (1) and the substance having an electron accepting property with
respect to the carbazole derivative represented by following General Formula (1)" has a
function of generating holes, carrier density is increased. Since conductivity is

improved as the result, changes in driving voltage dependent on a thickness of "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by following General Formula (1)" are a few. Therefore, by changing the thickness of "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by following General Formula (1)", a distance between the layer containing a light emitting substance and the first electrode or the second electrode can be easily adjusted.

10 [0017]

In other words, a length of light path through which emitted light passes (light path length) is easily adjusted in order to be a length capable of efficiently extracting light emission outward or a length for improving color purity of light emission extracted outward. In addition, by making thick the thickness of "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by following General Formula (1)", an asperity on a surface of the first electrode can be reduced, and a short circuit between the electrodes can be easily prevented.

[0018]

20 In addition, since "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by following General Formula (1)" has a favorable conductivity, it has a fine function of transporting holes as well.

[0019]

25 Therefore, the light emitting element of the present invention is characterized by

including a plurality of layers between a first electrode and a second electrode, in which the plurality of layers includes a layer containing a light emitting substance and at least one layer having a function of transporting holes, and

30 the layer having a function of transporting holes contains the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General

Formula (1).

[0020]

In addition, the light emitting element of the present invention in the above plurality of structures is characterized in that

5 the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the first electrode, and

10 an element structure is such that light is emitted when voltage is applied so that potential of the first electrode is higher than potential of the second electrode.

[0021]

In addition, the light emitting element of the present invention in the above plurality of structures is characterized in that

15 the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the second electrode, and

an element structure is such that light is emitted when voltage is applied so that potential of the first electrode is higher than potential of the second electrode.

20 [0022]

In addition, the light emitting element of the present invention in the above plurality of structures is characterized in that

25 the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is provided between the layer containing a light emitting substance and the first electrode, and between the layer containing a light emitting substance and the second electrode, and

an element structure is such that light is emitted when voltage is applied so that potential of the first electrode is higher than potential of the second electrode.

30 [0023]

As the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1), metal oxide can be given.

[0024]

And, it is preferable that oxide of any transition metal of Group 4 ~ Group 12 in the periodic table among the metal oxide is used as the substance having an electron accepting property with respect to the carbazole derivative represented by the above

5 General Formula (1).

[0025]

In addition, the carbazole derivative represented by the above General Formula (1) has two triphenylamine skeletons.

And, it is known that oxide of any transition metal of Group 4 ~ Group 8 in the
10 periodic table, such as molybdenum oxide (MoO_x), vanadium oxide (VO_x), ruthenium oxide (RuO_x), tungsten oxide (WO_x), rhenium oxide (ReO_x), titanium oxide (TiO_x), chromium oxide (CrO_x), zirconium oxide (ZrO_x), hafnium oxide (HfO_x), or tantalum oxide (TaO_x), especially has an electron accepting property with respect to this triphenylamine skeleton.

15 [0026]

Therefore, as the substance having an electron accepting property with respect to the carbazole derivative represented by above General Formula (1), it is preferable to use oxide of any transition metal of Group 4 ~ Group 8 in the periodic table, for
20 example, such as molybdenum oxide (MoO_x), vanadium oxide (VO_x), ruthenium oxide (RuO_x), tungsten oxide (WO_x), rhenium oxide (ReO_x), titanium oxide (TiO_x), chromium oxide (CrO_x), zirconium oxide (ZrO_x), hafnium oxide (HfO_x), or tantalum oxide (TaO_x).

[0027]

In addition, in "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with
25 respect to the carbazole derivative represented by General Formula (1)", a suitable mixing molar ratio of the substance having an electron accepting property and the carbazole derivative is the substance having an electron accepting property/ the carbazole derivative = 0.1 ~ 10, preferably 0.5 ~ 2.

[0028]

30 Note that the plurality of layers is made by combining a layer containing a substance having a high carrier injecting property, a layer containing a substance having

a high carrier transporting property, and the like. It is acceptable as long as the structure of the plurality of layers is a structure in which a light emitting region is formed in the layer containing a light emitting substance, in other words, a structure in which carriers (carrier) are recombined in the layer containing a light emitting substance.

- 5 The structure of the plurality of layers can be properly selected depending on the purpose.

[0029]

- In addition, the layer containing a light emitting substance may be a single layer or a multilayer. In addition, in the case of the multilayer, it is acceptable as long as at least one layer contains a light emitting substance.

[0030]

- Note that the light emitting element of the present invention may have a structure in which light generated by the recombination of carriers in the layer containing a light emitting substance is emitted outward from only either the first or second electrode, or may have a structure to emit outward from both the first and second electrodes.

[0031]

- In the case of emitting light from the first electrode side, the first electrode is formed from a translucent material, and in the case of emitting light from the second electrode side, the second electrode is formed from a translucent material. In the case of emitting light from both the first and second electrode sides, the first and second electrodes may both be formed from a translucent material.

[0032]

- In addition, the light emitting element of the present invention is preferably supported over a substrate. There is no specific limitation on the substrate, and one used in a conventional light emitting element, for example, such as one made from glass, quartz, transparent plastic, or the like, can be used.

[0033]

- A light emitting device of the present invention uses any of the light emitting elements described above as a pixel or a light source.

[0034]

An electronic device of the present invention uses the light emitting device,

which uses any of the light emitting elements described above as the pixel, for a display portion.

[0035]

- 5 The electronic device of the present invention uses the light emitting device, which uses any of the light emitting elements described above as the light source, for a lighting portion.

[Effect of the Invention]

[0036]

- 10 In the light emitting element of the present invention, by making at least one layer of the plurality of layers between the first electrode and the second electrode to be the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1), a problem of malfunctions of the light emitting element due to crystallization, which is generated when an anode is formed from metal oxide, can be solved and driving voltage can be reduced.

[0037]

- 20 In addition, in the light emitting element of the present invention, since electron transfer is performed even before the application of voltage in "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1)", "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1)" becomes a film having an extremely high conductivity. Therefore, it is possible to provide an electroluminescent element with low driving voltage and low power consumption.

[0038]

- 30 Further, there are a few cases of increasing driving voltage in proportion to making a thick film of "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1)".

[0039]

Therefore, "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1)" can be prevented from short circuits because the layer can be made thick without increasing voltage, optical design can be optimized, and a highly reliable electroluminescent element with high light emitting efficiency can be provided.

[0040]

Further, since "the layer containing the carbazole derivative represented by General Formula (1) and the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1)" is difficult to be crystallized, an electroluminescent element with a few malfunctions due to the crystallization of the layer can be obtained.

[Best Mode for Carrying out the Invention]

[0041]

Hereinafter, modes of the present invention are described. Note that it is easily understood by those skilled in the art that the present invention can be implemented in various different modes and various changes may be made in forms and details without departing from the spirit and the scope of the present invention. Therefore, the invention should not be interpreted as being limited to the descriptions of the embodiments.

[0042]

(Embodiment 1)

One mode of a light emitting element of the present invention is described with reference to FIG. 1.

[0043]

In FIG. 1, the light emitting element having a first layer 111, a second layer 112, a third layer 113, a fourth layer 114, a fifth layer 115 between a first electrode 101 and a second electrode 102 is shown.

[0044]

This first layer is a layer formed by mixing the carbazole derivative represented by General Formula (1) with the substance having an electron accepting property and respect to the carbazole derivative represented by General Formula (1). Since this first

layer has a function of generating holes, it is hereinafter called a hole generating layer.

The second layer 112 is a hole transport layer, the third layer 113 is a light emitting layer, and the fourth layer 114 is an electron transport layer. And, the fifth layer 115 is a layer having a function of generating electrons, and the fifth layer is hereinafter called an electron generating layer.

[0045]

When voltage is applied to the first electrode 101 and the second electrode 102 so that potential of the first electrode 101 is higher than potential of the second electrode 102, to the light emitting layer 113, holes are injected from the first electrode 101 side, and electrons are injected from the second electrode 102 side. Then, the holes and electrons injected to the light emitting layer 113 are recombined. The light emitting layer 113 contains a light emitting substance, and the light emitting substance becomes in an excited state by excitation energy generated through the recombination. The light emitting substance in the excited state emits light when returning to a ground state.

[0046]

In addition, the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) to the carbazole derivative represented by General Formula (1) is preferably contained so that a value of a molar ratio is 0.1 ~ 10, more preferably 0.5 ~ 2 (= the substance having an electron accepting property/ the carbazole derivative).

[0047]

Metal oxide can be given as the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1). In the metal oxide, to use oxide of any transition metal of Group 4 ~ Group 12 in the periodic table is preferable, and it is more preferable to use oxide of any transition metal of Group 4 ~ Group 8 in the periodic table, such as molybdenum oxide (MoO_x), vanadium oxide (VO_x), ruthenium oxide (RuO_x), tungsten oxide (WO_x), rhenium oxide (ReO_x), titanium oxide (TiO_x), chromium oxide (CrO_x), zirconium oxide (ZrO_x), hafnium oxide (HfO_x), or tantalum oxide (TaO_x).

[0048]

In addition, one kind or a plurality of kinds of substances having electron

accepting properties with respect to the carbazole derivative represented by General Formula (1) may be used.

[0049]

- By combining the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) and the carbazole derivative represented by General Formula (1), crystallization of the hole generating layer 111 can be suppressed and malfunctions of an element due to the crystallization can be reduced.

[0050]

- In the hole generating layer 111 having such a structure, the carbazole derivative represented by General Formula (1) are deprived of electrons by the substance having an electron accepting property. In other words, the carbazole derivative represented by General Formula (1) is oxidized and generates holes.

[0051]

- In addition, the light emitting layer 113 contains a light emitting substance. Here, the light emitting substance indicates a substance which can emit light of a desired wavelength with a favorable light emitting efficiency. The light emitting layer 113 may be a layer formed from only a light emitting substance. However, in the case where concentration quenching occurs, a mixed layer in which light emitting substances are dispersed into a layer made from a substance having an energy gap larger than an energy gap of the light emitting substance is preferable. By dispersedly containing the light emitting substances in the light emitting layer 113, the quenching of light emission due to the concentration can be prevented. Here, the energy gap indicates an energy gap between the LUMO level and the HOMO level.

- [0052]

There is no particular limitation on the light emitting substance, and a substance having favorable light emitting efficiency and capable of light emission of a desired wavelength may be used.

[0053]

- For example, in order to obtain red light emission, it is possible to use as the light emitting substance a substance exhibiting light emission having a peak of an emission spectrum at 600 nm to 680 nm, such as

- 4-dicyanomethylene-2-isopropyl-6-[2-(1,1,7,7-tetramethyljulolidine-9-yl)ethenyl]-4H-pyran (abbr.: DCJTI),
 4-dicyanomethylene-2-methyl-6-[2-(1,1,7,7-tetramethyljulolidine-9-yl)ethenyl]-4H-pyran (abbr.: DCJT),
 5 4-dicyanomethylene-2-tert-butyl-6-[2-(1,1,7,7-tetramethyljulolidine-9-yl)ethenyl]-4H-pyran (abbr.: DCJTB), periflanthene, or
 2,5-dicyano-1,4-bis[2-(10-methoxy-1,1,7,7-tetramethyljulolidine-9-yl)ethenyl]benzene. [0054]

- In addition, in order to obtain green light emission, it is possible to use as the
 10 light emitting substance a substance exhibiting light emission having a peak of an emission spectrum at 500 nm to 550 nm, such as N,N'-dimethylquinacridon (abbr.: DMQd), coumarin 6, coumarin 545T, or tris(8-quinolinolato)aluminum (abbr.: Alq₃). [0055]

- In addition, in order to obtain blue light emission, it is possible to use as the
 15 light emitting substance a substance exhibiting light emission having a peak of an emission spectrum at 420 nm to 500 nm, such as 9,10-bis(2-naphthyl)-tert-butylanthracene (abbr.: t-BuDNA), 9,9'-bianthryl, 9,10-diphenylanthracene (abbr.: DPA), 9,10-bis(2-naphthyl)anthracene (abbr.: DNA), bis(2-methyl-8-quinolinolato)-4-phenylphenolato-gallium (abbr.: BGaq), or
 20 bis(2-methyl-8-quinolinolato)-4-phenylphenolato-aluminum (abbr.: BAq). [0056]

- In addition to the above substances emitting fluorescence, it is also possible to use as the light emitting substance a substance emitting phosphorescence such as bis[2-(3,5-bis(trifluoromethyl)phenyl)pyridinato-N,C²]iridium(III)picolinate (abbr.: Ir(CF₃ppy)₂(pic)),
 25 bis[2-(4,6-difluorophenyl)pyridinato-N,C²]iridium(III)acetylacetonate (abbr.: Flr(acac)), bis[2-(4,6-difluorophenyl)pyridinato-N,C²]iridium(III)picolinate (abbr.: Flr(pic)), or tris(2-phenylpyridinato-N,C²)iridium (abbr.: Ir(ppy)₃). [0057]

- 30 In addition, there is no particular limitation on the substance, which is contained in the light emitting layer 113 together with the light emitting substances and used to make the light emitting substances in a dispersed state, and it may be properly

selected in consideration of energy gap or the like of the substance used as the light emitting substances.

[0058]

For example, a metal complex such as bis[2-(2-hydroxyphenyl)pyridinato]zinc (abbr.: Znpp₂) or bis[2-(2-hydroxyphenyl)benzoxazolato]zinc (abbr.: ZnBOX) or the like can be used together with the light emitting substance, as well as an anthracene derivative such as 9,10-di(2-naphthyl)-2-tert-butylanthracene (abbr.: t-BuDNA), a carbazole derivative such as 4,4'-bis(N-carbazolyl)biphenyl (abbr.: CBP), or a quinoxaline derivative such as 2,3-bis(4-diphenylaminophenyl)quinoxaline (abbr.: TPAQn) or 2,3-bis{4-[N-(1-naphthyl)-N-phenylamino]phenyl}dibenzo[f,h]quinoxaline (abbr.: NPADiBzQn).

[0059]

The hole transport layer 112 is a layer having a function of transporting holes, and in the light emitting element of the present embodiment, it has a function of transporting holes from the hole generating layer 111 to the light emitting layer 113.

By providing the hole transport layer 112, a distance between the hole generating layer 111 and the light emitting layer 113 can be increased; as a result, quenching of light emission due to metal contained in the hole generating layer 111 can be prevented.

[0060]

The hole transport layer is preferably formed by using a substance having a high hole transporting property, and in particular, is preferably formed by using a substance having a hole mobility of $1 \times 10^{-6} \text{ cm}^2/\text{Vs}$ or more.

Note that the substance having a high hole transporting property indicates a substance in which holes have higher mobility than electrons and a value of a ratio of the hole mobility to the electron mobility (= hole mobility/electron mobility) is more than 100.

[0061]

As specific examples of a substance capable of being used to form the hole transport layer 112, 4,4'-bis[N-(1-naphthyl)-N-phenylamino]biphenyl (abbr.: NPB), 4,4'-bis[N-(3-methylphenyl)-N-phenylamino]biphenyl (abbr.: TPD),

- 4,4',4''-tris(N,N-diphenylamino)triphenylamine (abbr.: TDATA),
 4,4',4''-tris[N-(3-methylphenyl)-N-phenylamino]triphenylamine (abbr.: MTDATA),
 4,4'-bis{N-[4-(N,N-di-m-tolylamino)phenyl]-N-phenylamino}biphenyl (abbr.: DNTPD),
 1,3,5-tris[N,N-di(m-tolyl)amino]benzene (abbr.: m-MTDAB),
 5 4,4',4''-tris(N-carbazolyl)triphenylamine (abbr.: TCTA), phthalocyanine (abbr.: H₂Pc),
 copper phthalocyanine (abbr.: CuPc), vanadyl phthalocyanine (abbr.: VOpc), and the
 like can be given.

[0062]

- The electron transport layer 114 is a layer having a function of transporting
 10 electrons, and in the light emitting element of the present embodiment, it has a function
 of transporting electrons from the electron generating layer 115 to the light emitting
 layer 113. By providing the electron transport layer 114, a distance between the
 second electrode 102 and the light emitting layer 113 can be increased; as a result,
 quenching of light emission due to metal included in the second electrode 102 can be
 15 prevented.

[0063]

- The electron transport layer is preferably formed by using a substance having a
 high electron transporting property, and in particular, is preferably formed by using a
 substance having an electron mobility of 1×10^{-6} cm²/Vs or more. Note that the
 20 substance having a high electron transporting property indicates a substance in which
 electrons have higher mobility than holes and a value of a ratio of the electron mobility
 to the hole mobility (= electron mobility/hole mobility) is more than 100.

[0064]

- As specific examples of the substance capable of being used to form the
 25 electron transport layer 114, 2-(4-biphenyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole
 (abbr.: PBD), 1,3-bis[5-(p-tert-butylphenyl)-1,3,4-oxadiazole-2-yl]benzene (abbr.:
 OXD-7), 3-(4-tert-butylphenyl)-4-phenyl-5-(4-biphenyl)-1,2,4-triazole (abbr.: TAZ),
 3-(4-tert-butylphenyl)-4-(4-ethylphenyl)-5-(4-biphenyl)-1,2,4-triazole (abbr.:
 p-EtTAZ), bathophenanthroline (abbr.: BPhen), bathocuproine (abbr.: BCP),
 30 4,4-bis(5-methylbenzoxazol-2-yl)stilbene (BzOs), and the like can be given, as well as
 metal complexes such as tris(8-quinolinolato)aluminum (abbr.: Alq₃),

- tris(4-methyl-8-quinolinolato)aluminum (abbr.: Almq₃),
 bis(10-hydroxybenzo[h]quinolinato)beryllium (abbr.: BeBq₂),
 bis(2-methyl-8-quinolinolato)-4-phenylphenolato-aluminum (abbr.: BAiq),
 bis[2-(2-hydroxyphenyl)benzoxazolato]zinc (abbr.: Zn(BOX)₂), and
 5 bis[2-(2-hydroxyphenyl)benzothiazolato]zinc (abbr.: Zn(BTZ)₂).
 [0065]

Note that the hole transport layer 112 and the electron transport layer 114 may each be formed by using a bipolar substance as well as the above mentioned substance. The bipolar substance indicates a substance, when comparing carrier mobility of either
 10 electrons or holes to a carrier mobility of the other, in which a value of a ratio of one carrier mobility to the other carrier mobility is 100 or less, preferably 10 or less.
 [0066]

As the bipolar substance, for example,
 2,3-bis(4-diphenylaminophenyl)quinoxaline (abbr.: TPAQn),
 15 2,3-bis{4-[N-(1-naphthyl)-N-phenylamino]phenyl}-dibenzo[f,h]quinoxaline (abbr.: NPADiBzQn), or the like can be given. Among the bipolar substances, it is especially preferable to use a substance having a hole and electron mobility of 1×10^{-6} cm²/Vs or more. In addition, the same bipolar substance may be used to form the hole transport layer 112 and the electron transport layer 114.
 20 [0067]

The electron generating layer 115 is a layer for generating electrons, and can be formed by mixing at least one substance selected from the substance having a high electron transporting property and the bipolar substance with a substance having an electron donating property with respect to these substances. Here, among the
 25 substance having a high electron transporting property and the bipolar substance, a substance having an electron mobility of 1×10^{-6} cm²/Vs or more is especially preferable.
 [0068]

As for the substance having a high electron transporting property and the
 30 bipolar substance, those mentioned above can each be used. In addition, as the substance having an electron donating property, a substance selected from alkali metal

and alkaline earth metal, specifically, lithium (Li), calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), or the like can be used. In addition, at least one substance selected from oxide of alkali metal, oxide of alkaline earth metal, nitride of alkali metal, nitride of alkaline earth metal, and the like, specifically, lithium oxide (Li_2O), calcium oxide (CaO), sodium oxide (Na_2O), potassium oxide (K_2O), magnesium oxide (MgO), lithium fluoride (LiF), cesium fluoride (CsF), calcium fluoride (CaF_2) and the like, can be used as the substance having an electron donating property.

[0069]

The first electrode 101 may be formed by using a substance having a high work function such as gold (Au), platinum (Pt), nickel (Ni), tungsten (W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), palladium (Pd), or tantalum nitride or may be formed by using a substance having a low work function such as aluminum or magnesium, as well as indium tin oxide, indium tin oxide containing silicon oxide, or indium oxide containing zinc oxide of 2 ~ 20 %.

[0070]

As described above, in the light emitting element of the present embodiment, the first electrode 101 can be formed independently of work function of a substance. This is because the hole generating layer 111 is provided between the first electrode 101 and the light emitting layer 113.

[0071]

In addition, the second electrode 102 may be formed by using a substance having a high work function such as gold (Au), platinum (Pt), nickel (Ni), tungsten (W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), palladium (Pd), or tantalum nitride or may be formed by using a substance having a low work function such as aluminum or magnesium, as well as indium tin oxide, indium tin oxide containing silicon oxide, or indium oxide containing zinc oxide of 2 ~ 20 %.

[0072]

As described above, in the light emitting element of the present embodiment, the second electrode 102 can be formed independently of work function of a substance. This is because the electron generating layer 115 is provided between the second electrode 102 and the light emitting layer 113.

[0073]

Note that, although the light emitting element having the hole transport layer 112, the electron transport layer 114, and the like, in addition to the hole generating layer 111 and the light emitting layer 113, is described in the present embodiment, a mode of the light emitting element is not necessarily limited thereto.

[0074]

For example, a light emitting element in which an electron injection layer 116 instead of the electron generating layer 115 is provided as shown in FIG. 3 may be acceptable. The electron injection layer 116 is a layer having a function of supporting the injection of electrons from the second electrode 102 to the electron transport layer 114.

[0075]

By providing the electron injection layer 116, a gap of electron affinity between the second electrode 102 and the electron transport layer 114 is reduced, and electrons become easy to be injected. The electron injection layer 116 is preferably formed by using a substance having larger electron affinity than the substance forming the electron transport layer 114 and smaller electron affinity than the substance forming the second electrode 102, or a substance which bends an energy band when provided as a thin film of 1 ~ 2 nm between the electron transport layer 114 and the second electrode 102.

[0076]

As a specific example of the substance capable of being used to form the electron injection layer 116, an inorganic material such as alkali metal, alkaline earth metal, fluoride of alkali metal, fluoride of alkaline earth metal, oxide of alkali metal, or oxide of alkaline earth metal can be given. These substances are favorable because they bend the energy band when provided as a thin film.

[0077]

In addition, as well as the inorganic material, a substance capable of being used to form the electron transport layer 114 such as BPhen, BCP, BCP, p-EtTAZ, or TAZ can be used as a substance to form the electron injection layer 116 by selecting a substance having larger electron affinity than the substance used to form the electron transport layer 114 from these substances.

[0078]

In other words, it is preferable to form the electron injection layer 116 so that electron affinity in the electron injection layer 116 is relatively larger than electron affinity in the electron transport layer 114. Note that, in a case of providing the electron injection layer 116, the second electrode 102 is preferably formed by using a substance having a low work function such as aluminum.

[0079]

In addition, as shown in FIG. 4, a hole blocking layer 117 may be provided between the light emitting layer 113 and the electron transport layer 114. By providing the hole blocking layer 117, holes can be prevented from flowing through the light emitting layer 113 toward the second electrode 102 and recombination efficiency of carriers can be increased. In addition, the excitation energy generated in the light emitting layer 113 can be prevented from moving to another layer such as the electron transport layer 114.

[0080]

The hole blocking layer 117 can be formed by selecting, in particular, a substance having larger ionization potential and excitation energy than the substance used to form the light emitting layer 113 from substances capable of being used to form the electron transport layer 114 such as BA1q, OXD-7, TAZ, and BPhen.

[0081]

In other words, the hole blocking layer 117 may be formed as long as the ionization potential in the hole blocking layer 117 is relatively larger than ionization potential in the electron transport layer 114.

[0082]

Similarly, a layer for blocking electrons to flow toward the first electrode 101 through the light emitting layer 113 may be provided also between the light emitting layer 113 and the hole transport layer 112.

[0083]

Note that a practitioner of the invention can properly decide whether the hole transport layer 112, the electron transport layer 114, or the like is provided or not.

These layers are not necessarily provided, for example, in the case where a defect such as quenching due to metal is not caused even when the hole transport layer 112 and the electron transport layer 114 are not provided.

[0084]

In the light emitting element of the present embodiment described above, changes in driving voltage dependent on a thickness of the hole generating layer 111 are a few. Therefore, by changing the thickness of the hole generating layer 111, a distance between the light emitting layer 113 and the first electrode 101 can be easily adjusted.

[0085]

In other words, a length of light path through which emitted light passes (light path length) can be easily adjusted in order to be a length capable of efficiently extracting light emission to outward or a length for improving color purity of light emission extracted outward. In addition, by making the thickness of the hole generating layer 111 thick, an asperity on a surface of the first electrode 101 can be reduced, and a short circuit between the electrodes can be easily prevented.

[0086]

In addition, in the light emitting element of the present embodiment, changes in driving voltage dependent on a thickness of the electron generating layer 115 are a few. Therefore, a length of light path through which emitted light passes (light path length) can be easily adjusted by changing the thickness of the electron generating layer 115. In addition, by making the thickness of the electron generating layer 115 thick, an asperity on a surface of the second electrode 102 can be reduced and a short circuit between the electrodes can be easily prevented.

[0087]

(Embodiment 2)

One mode of a light emitting element of the present invention is described with reference to FIG. 2.

[0088]

In FIG. 2, a light emitting element having a first layer 211, a second layer 212, and a third layer 213 between a first electrode 201 and a second electrode 202 is shown. The first layer 211 generates holes, and the second layer 212 generates electrons. The third layer 213 is made by sequentially stacking an electron transport layer 221, a light emitting layer 222, a hole transport layer 223, and a hole generating layer 224.

[0089]

Here, the hole generating layer 224 is provided on the first electrode 201 side than the light emitting layer 222, and the electron transport layer 221 is provided on the second electrode 202 side than the light emitting layer 222. When voltage is applied to the first electrode 201 and the second electrode so that potential of the first electrode 201 is higher than potential of the second electrode 202, holes are injected to the second electrode 202 from the first layer 211. In addition, to the third layer 213, electrons are injected from the second layer 212, and holes are injected from the first electrode 201. The electrons and holes injected to the third layer 213 are recombined in the light emitting layer 222. The light emitting layer 222 contains a light emitting substance, and the light emitting substance becomes in an excited state by excitation energy generated through the recombination. The light emitting substance in the excited state emits light when returning to a ground state.

[0090]

The first layer 211 and the hole generating layer 224 each are layers formed by mixing a carbazole derivative represented by General Formula (1) and a substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1). In the first layer 211 and the hole generating layer 224, the carbazole derivative represented by General Formula (1) are deprived of electrons by the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1). In other words, the carbazole derivative represented by General Formula (1) is oxidized and generates holes.

[0091]

Note that in each of the first layer 211 and the hole generating layer 224, it is preferable to use in particular the carbazole derivative having a hole mobility of 1×10^{-6} cm²/Vs of the carbazole derivative represented by General Formula (1). In addition, the substance having an electron accepting property with respect to the carbazole derivative represented by General Formula (1) is preferably contained in each layer so that a value of a molar ratio to the carbazole derivative represented by General Formula (1) is 0.1 ~ 10, more preferably 0.5 ~ 2 (= the substance having an electron accepting property/ anthracene derivative). In addition, although there is no particular limitation

on the substance having an electron accepting property, metal oxide such as molybdenum oxide, vanadium oxide, ruthenium oxide, or rhenium oxide is preferably used. By combining these metal oxide, crystallization of the first layer 211 or the hole generating layer 224 can be suppressed and malfunctions of an element due to the crystallization can be decreased.

[0092]

The second layer 212 is a layer for generating electrons, and can be formed by mixing at least one substance selected from the substance having a high electron transporting property and the bipolar substance with a substance having an electron donating property with respect to these substances.

[0093]

Here, a substance having an electron mobility of $1 \times 10^{-6} \text{ cm}^2/\text{Vs}$ or more of the substance having a high electron transporting property and the bipolar substance are especially preferable. As the substance having a high electron transporting property and the bipolar substance, each of those mentioned above can be used.

[0094]

In addition, as the substance having an electron donating property, a substance selected from alkali metal and alkaline earth metal, specifically, lithium (Li), calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), or the like can be used. In addition, oxide of alkali metal, oxide of alkaline earth metal, nitride of alkali metal, nitride of alkaline earth metal, or the like, specifically, lithium oxide (Li_2O), calcium oxide (CaO), sodium oxide (Na_2O), potassium oxide (K_2O), magnesium oxide (MgO), lithium fluoride (LiF), cesium fluoride (CsF), calcium fluoride (CaF_2), or the like can also be used as the substance having an electron donating property.

[0095]

The electron transport layer 221 is a layer having a function of transporting electrons, and in the light emitting element of the present embodiment, it has a function of transporting electrons from the second layer 212 to the light emitting layer 222. By providing the electron transport layer 221, a distance between the second layer 212 and the light emitting layer 222 can be increased; as a result, quenching of light emission due to metal contained in the second layer 212 can be prevented. The electron transport layer is preferably formed by using a substance having a high electron

transporting property, and in particular, is preferably formed by using a substance having an electron mobility of $1 \times 10^{-6} \text{ cm}^2/\text{Vs}$ or more. The description of the specific examples of the substance capable of being used to form the electron transport layer 114 in Embodiment 1 is referred to for specific examples of the substance capable of being used to form the electron transport layer 221.

[0096]

The light emitting layer 222 contains a light emitting substance. The light emitting layer 222 may be a layer formed from only a light emitting substance; however, in the case where concentration quenching occurs, it is preferably a mixed layer in which light emitting substances are dispersed into a layer made from a substance having an energy gap larger than an energy gap of the light emitting substance. By dispersedly containing the light emitting substances in the light emitting layer 222, the quenching of light emission due to the concentration can be prevented. Note that the description of the light emitting substance in Embodiment 1 is referred to for the light emitting substances. Here, the description of the substance which is included in the light emitting layer 113 together with the light emitting substances described in Embodiment 1 and is used to make the light emitting substances in a dispersed state is referred to for the substance which is contained in the light emitting layer 222 together with the light emitting substances and is used to make the light emitting substances in a dispersed state.

[0097]

The hole transport layer 223 is a layer having a function of transporting holes, and in the light emitting element of the present embodiment, it has a function of transporting holes from the hole generating layer 224 to the light emitting layer 222. By providing the hole transport layer 223, a distance between the hole generating layer 224 and the light emitting layer 222 can be increased; as a result, quenching of light emission due to metal contained in the hole generating layer 224 can be prevented. The hole transport layer 223 is preferably formed by using a substance having a high hole transporting property, and in particular, is preferably formed by using a substance having a hole mobility of $1 \times 10^{-6} \text{ cm}^2/\text{Vs}$ or more. The description of the specific examples of the substance capable of being used to form the hole transport layer 112 in

Embodiment 1 is referred to for specific examples of the substance capable of being used to form the hole transport layer 223.

[0098]

5 The first electrode 201 may be formed by using a substance having a high work function such as gold (Au), platinum (Pt), nickel (Ni), tungsten (W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), palladium (Pd), or tantalum nitride or may be formed by using a substance having a low work function such as aluminum or magnesium, as well as indium tin oxide, indium tin oxide containing silicon oxide, or indium oxide containing zinc oxide of 2 ~ 20 %. As described above, 10 in the light emitting element of the present embodiment, the first electrode 201 can be formed independently of work function of a substance. This is because the hole generating layer 224 is provided between the first electrode 201 and the light emitting layer 222.

[0099]

15 In addition, the second electrode 202 may also be formed by using a substance having a high work function such as gold (Au), platinum (Pt), nickel (Ni), tungsten (W), chromium (Cr), molybdenum (Mo), iron (Fe), cobalt (Co), copper (Cu), palladium (Pd), or tantalum nitride or may be formed by using a substance having a low work function such as aluminum or magnesium, as well as indium tin oxide, indium tin oxide 20 containing silicon oxide, indium oxide containing zinc oxide of 2 ~ 20 %. As described above, in the light emitting element of the present embodiment, the second electrode 202 can be formed independently of work function of a substance. This is because the first layer 211 and the second layer 212 are provided between the second electrode 202 and the light emitting layer 222.

25 [0100]

Note that, in the present embodiment, the light emitting element in which the third layer 213 which is a layer containing the light emitting substance is a multilayer including the electron transport layer 221, the light emitting layer 222, the hole transport layer 223, the hole generating layer 224 is described. However, the mode of the light 30 emitting element is not necessarily limited thereto.

[0101]

For example, a light emitting element in which a hole injection layer 225 instead of the hole generating layer 224 is provided, as shown in FIG. 5, may be acceptable. The hole injection layer 225 is a layer having a function of supporting the injection of holes from the first electrode 201 to the hole transport layer 223. By providing the hole injection layer 225, a gap of ionization potential between the first electrode 201 and the hole transport layer 223 is reduced, and holes become easy to be injected. The hole injection layer 225 is preferably formed by using a substance having smaller ionization potential than the substance forming the hole transport layer 223 and having larger ionization potential than the substance forming the first electrode 201, or a substance which bends an energy band when provided as a thin film of 1 ~ 2 nm between the hole transport layer 223 and the second electrode 202. As specific examples of the substance capable of being used to form the hole injection layer 225, phthalocyanine-based compound such as phthalocyanine (abbr.: H₂Pc) or copper phthalocyanine (CuPc), a high molecular such as a poly(ethylene dioxathiophene)/poly(styrenesulfonic acid) aqueous solution (PEDOT/PSS), and the like can be given. It is preferable to form the hole injection layer 225 so that ionization potential in the hole injection layer 225 is relatively larger than ionization potential in the hole transport layer 223. Note that, in the case of providing the hole injection layer 225, the first electrode 201 is preferably formed by using a substance having a high work function such as indium tin oxide.

[0102]

In addition, as shown in FIG. 6, a hole blocking layer 226 may be provided between the light emitting layer 222 and the electron transport layer 221. By providing the hole blocking layer 226, holes can be prevented from flowing through the light emitting layer 222 toward the second electrode 202 and recombination efficiency of carriers can be increased. In addition, the excitation energy generated in the light emitting layer 222 can be prevented from moving to another layer such as the electron transport layer 221.

[0103]

The hole blocking layer 226 can be formed by selecting, in particular, a substance having larger ionization potential and excitation energy than the substance used to form the light emitting layer 222 from substances capable of being used to form

the electron transport layer 221 such as BA1q, OXD-7, TAZ, and BPhen. In other words, the hole blocking layer 117 may be formed as long as the ionization potential in the hole blocking layer 226 is relatively larger than ionization potential in the electron transport layer 221. Similarly, a layer for blocking electrons to flow toward the first electrode 201 through the light emitting layer 222 may be provided between the light emitting layer 222 and the hole transport layer 223.

[0104]

Note that a practitioner of the invention can properly decide whether the hole transport layer 223, the electron transport layer 221 is provided or not. These layers are not necessarily provided, for example, in the case where a defect such as quenching due to metal is not caused even when the hole transport layer 223 and the electron transport layer 221 are not provided.

[0105]

In addition, in the above-described light emitting element, the difference between electron affinity of the substance having a high electron transporting property contained in the second layer 212 and electron affinity of a substance contained in a layer of the third layer 213, which has contact with the second layer 212, is preferably 2 eV or less, more preferably, 1.5 eV or less. More specifically, when the second layer 212 is in contact with the electron transport layer 221 like the light emitting element shown in FIG. 2, the difference of electron affinity between the substance having an electron transporting property contained in the second layer 212 and the substance having an electron transporting property contained in the electron transport layer 221 is preferably 2 eV or less, more preferably, 1.5 eV or less. By connecting the second layer 212 to the third layer 213 in this manner, electrons can be efficiently injected to the third layer 213 from the second layer 212.

[0106]

The light emitting element of the present invention described above is an element in which changes in driving voltage dependent on thicknesses of the first layer 211 and the hole generating layer 224 are a few. Therefore, by changing the thickness of the first layer 211 or the hole generating layer 224, a distance between the light emitting layer 222 and the first electrode 201 or the second electrode 202 can be easily adjusted. In other words, a length of light path through which emitted light passes

(light path length) can be easily adjusted in order to be a length capable of efficiently extracting light emission outward or a length for improving color purity of light emission extracted outward. In addition, an asperity on a surface of the first electrode 201 or the second electrode 202 can be reduced by making the thickness of the first layer 211 or the hole generating layer 224 thick, and a short circuit between the electrodes can be easily prevented.

[0107]

(Embodiment 3)

The light emitting element of the present invention can reduce malfunctions due to oxidation and crystallization of a compound. In addition, by making the thickness of a hole generating layer thick, a short circuit between electrodes can be prevented. In addition, by changing the thickness of the hole generating layer, light path length can be adjusted, light emission outward extraction efficiency can be increased, and light emission with good color purity can be obtained. Therefore, by using the light emitting element of the present invention as a pixel, a favorable light emitting device with a few display defects due to the malfunctions of the light emitting element can be obtained. In addition, by using the light emitting element of the present invention as a pixel, a light emitting device which can provide an image with favorable display color can be obtained. In addition, by using the light emitting element of the present invention as a light source, a light emitting device which can favorably perform lighting with a few defects due to the malfunctions of the light emitting element can be obtained.

[0108]

In the present embodiment, a circuit configuration of a light emitting device having a display function and a driving method are described with reference to FIGS. 7 ~ 11.

[0109]

FIG. 7 is a schematic view seen from above a light emitting device using the present invention. In FIG. 7, a pixel portion 6511, a source signal line driver circuit 6512, a writing gate signal line driver circuit 6513, and an erasing gate signal line driver circuit 6514 are provided over a substrate 6500. The source signal line driver circuit 6512, the writing gate signal line driver circuit 6513, and the erasing gate signal line

driver circuit 6514 are each connected to an FPC (flexible printed circuit) 6503, which is an external input terminal, through wiring groups. And, the source signal line driver circuit 6512, the writing gate signal line driver circuit 6513, and the erasing gate signal line driver circuit 6514 each receive video signals, clock signals, start signals, reset signals, or the like from the FPC 6503. In addition, a printed wiring board (PWB) 6504 is attached to the FPC 6503. Note that a driver circuit portion is not necessarily provided over the same substrate as the pixel portion 6511 as described above, and for example, may be provided outside the substrate by utilizing an FPC on which a wiring pattern is formed and over which an IC chip is mounted (TCP), or the like.

10 [0110]

In the pixel portion 6511, a plurality of source signal lines extending in a column direction is aligned side by side in a row direction. In addition, current supply lines are aligned side by side in a row direction. In addition, in the pixel portion 6511, a plurality of gate signal lines extending in a row direction is aligned side by side in a column direction. In addition, in the pixel portion 6511, a plurality of a pair of circuits including light emitting elements is aligned.

15

[0111]

FIG. 8 is a diagram showing a circuit for operating one pixel. The circuit shown in FIG. 8 includes a first transistor 901, a second transistor 902, and a light emitting element 903.

20

[0112]

Each of the first transistor 901 and the second transistor 902 is a three-terminal element including a gate electrode, a drain region, and a source region, and includes a channel region between the drain region and the source region. Here, the source region and the drain region are changed depending on the configuration of the transistor, an operation condition, and the like; therefore, it is difficult to determine which is the source region or the drain region. Consequently, in the present embodiment, the regions serving as the source or the drain are each denoted as a first electrode, a second electrode.

25

30 [0113]

A gate signal line 911 and a writing gate signal line driver circuit 913 are provided to be in an electrically connected or disconnected state by a switch 918. In

addition, the gate signal line 911 and an erasing gate signal line driver circuit 914 are provided to be in an electrically connected or disconnected state by a switch 919. In addition, a source signal line 912 is provided to be electrically connected to either a source signal line driver circuit 915 or a power source 916 by a switch 920. And, a gate of the first transistor 901 is electrically connected to the gate signal line 911. In addition, a first electrode of the first transistor is electrically connected to the source signal line 912, and a second electrode is electrically connected to a gate electrode of the second transistor 902. A first electrode of the second transistor 902 is electrically connected to a current supply line 917, and a second electrode is electrically connected to one electrode included in the light emitting element 903. Note that, the switch 918 may be included in the writing gate signal line driver circuit 913. In addition, the switch 919 may also be included in the erasing gate signal line driver circuit 914. In addition, the switch 920 may also be included in the source signal line driver circuit 915.

[0114]

In addition, there is no particular limitation on the arrangement of the transistors, the light emitting element, and the like in the pixel portion. For example, it is possible to arrange as shown in a top view of FIG. 9. In FIG. 9, a first electrode of a first transistor 1001 is connected to a source signal line 1004, and a second electrode is connected to a gate electrode of a second transistor 1002. In addition, a first electrode of the second transistor is connected to a current supply line 1005, and a second electrode is connected to an electrode 1006 of a light emitting element. A part of a gate signal line 1003 functions as a gate electrode of the first transistor 1001.

[0115]

Next, a driving method is described. FIG. 10 is a diagram for explaining the operation of a frame with time passage. In FIG. 10, a lateral direction indicates time passage, and a longitudinal direction indicates the number of scanning stages of a gate signal line.

[0116]

When image display is performed using a light emitting device of the present invention, screen rewriting operations and displaying operations are carried out repeatedly in the display period. There is no particular limitation on the number of

these rewriting operations; however, at least about 60 times in 1 second is preferable so that a person who watches an image does not sense flicker (flicker). Here, a period performing the rewriting operations and displaying operations for one image (1 frame) is referred to as 1 frame period.

5 [0117]

As shown in FIG. 10, 1 frame is time-divided into four sub-frames 501, 502, 503, 504 including writing periods 501a, 502a, 503a, 504a and holding periods 501b, 502b, 503b, 504b. The light emitting element supplied with a signal for light emission is in a light emitting state during the holding periods. The length ratio of the holding periods in each sub-frame is, the first sub-frame 501 : the second sub-frame 502 : the third sub-frame 503 : the fourth sub-frame 504 = $2^3 : 2^2 : 2^1 : 2^0 = 8 : 4 : 2 : 1$. This allows displaying 4-bit gray scale. Note that the number of bits and the number of the gray scales are not limited to those shown here. For example, 8 sub-frames may be provided so that 8-bit gray scale can be performed.

15 [0118]

The operation in 1 frame is described. First, in the sub-frame 501, the writing operation is performed on a first row to a last row, sequentially. Therefore, the starting time of the writing period is varied depending on a row. The rows in which the writing period 501a is terminated sequentially moves to the holding period 501b. In the holding period, the light emitting element supplied with a signal for light emission is in a light emitting state. In addition, the rows in which the holding period 501b is terminated sequentially moves to the next sub-frame 502, and a writing operation is sequentially performed on the first row to the last row in the same manner as in the case of the sub-frame 501. The above-mentioned operations are carried out repeatedly up to the holding period 504b of the sub-frame 504, and are terminated. When the operation in the sub-frame 504 is terminated, it moves to the next frame. In this manner, the total time of the light-emitting time in each sub-frame is to be the light emitting time of each light emitting element in 1 frame. By varying this light emitting time for each light emitting element and combining variously within one pixel, various display colors with different brightness and chromaticity can be formed.

30 [0119]

When the holding period is intended to be forcibly terminated in the row in

which the writing operation has already been terminated and is moved to the holding period prior to terminating the writing operation up to the last row as in the sub-frame 504, it is preferable to provide an erasing period 504c after the holding period 504b and to control forcibly to be in a non-light emitting state. And, the row which is made
5 forcibly to be in a non-light emitting state keeps the non-light emitting state for a certain period (this period is referred to as a non-light emitting period 504d). And, right after terminating the writing period in the last row, it moves to a writing period of the next (or a frame) sequentially from the first row. This can prevent the writing period of the sub-frame 504 and the writing period in the next sub-frame from overlapping.

10 [0120]

Note that in the present embodiment, although the sub-frames 501 to 504 are arranged sequentially from one with a long holding period, they are not necessarily arranged as in the present example. For example, it is acceptable to arrange sequentially from one with a short holding period, or those with a long and short
15 holding periods may be arranged randomly. In addition, sub-frames may further be divided into a plurality of frames. In other words, scanning of gate signal lines may be performed plural times during a period of supplying the same video signals.

[0121]

Here, the operations in the writing period and the erasing period of the circuits
20 shown in FIG. 8 are described.

[0122]

First, the operation in the writing period is described. In the writing period, the gate signal line 911 in the n -th row (n is a natural number) is electrically connected to the writing gate signal line driver circuit 913 via the switch 918, and is not connected
25 to the erasing gate signal line driver circuit 914. In addition, the source signal line 912 is electrically connected to the source signal line driver circuit via the switch 920. Here, a signal is input in the gate of the first transistor 901 connected to the gate signal line 911 in the n -th row (n is a natural number), and the first transistor 901 is turned on. And, at this moment, video signals are simultaneously input in the source signal lines in
30 the first column to the last column. Note that, the video signals input from the source signal line 912 in each column are independent of each other. The video signals input from the source signal line 912 are input in the gate electrode of the second transistor

902 via the first transistor 901 connected to each source signal line. At this moment, a current value supplied from the current supply line 917 to the light emitting element 903 is determined depending on the signals input in the second transistor 902. And, dependent on the current value, light emission or non-light emission of the light emitting element 903 is determined. For example, when the second transistor 902 is a P-channel type, the light emitting element 903 emits light by inputting a Low Level signal in the gate electrode of the second transistor 902. On the other hand, when the second transistor 902 is an N-channel type, the light emitting element 903 emits light by inputting a High Level signal in the gate electrode of the second transistor 902.

[0123]

Next, the operation in the erasing period is described. In the erasing period, the gate signal line 911 in the n-th row (n is a natural number) is electrically connected to the erasing gate signal line driver circuit 914 via the switch 919, and is not connected to the writing gate signal line driver circuit 913. In addition, the source signal line 912 is electrically connected to the power source 916 via the switch 920. Here, a signal is input in the gate of the first transistor 901 connected to the gate signal line 911 in the n-th row, and the first transistor 901 is turned on. And, at this moment, erasing signals are simultaneously input in the source signal lines in the first column to the last column. The erasing signals input from the source signal line 912 are input in the gate electrode of the second transistor 902 via the first transistor 901 connected to each source signal line. At this time, the supply of current from the current supply line 917 to the light emitting element 903 is blocked by the signals input in the second transistor 902. And, the light emitting element 903 is forcibly made to be non-light emitting. For example, when the second transistor 902 is a P-channel type, the light emitting element 903 becomes non-light emitting by inputting a High Level signal in the gate electrode of the second transistor 902. On the other hand, when the second transistor 902 is an N-channel type, the light emitting element 903 becomes non-light emitting by inputting a Low Level signal in the gate electrode of the second transistor 902.

[0124]

Note that, in the erasing period, a signal for erasing is input in the n-th row (n is a natural number) by the above-mentioned operation. However, as mentioned above, the n-th row is in the erasing period while another row (referred to as an m-th row (m is

a natural number)) is in the writing period in some cases. In such a case, since it is necessary to input a signal for erasing in the n -th row and a signal for writing in the m -th row by utilizing the source signal line in the same column, the operation mentioned as following is preferably carried out.

5 [0125]

Right after the light emitting element 903 in the n -th row becomes non-light emitting by the above-described operation in the erasing period, the gate signal line and the erasing gate signal line driver circuit 914 are in a disconnected state, while the source signal line and the source signal line driver circuit 915 are connected by
10 switching the switch 918. And, the source signal line and the source signal line driver circuit 915 are connected, while the gate signal line and the writing gate signal line driver circuit 913 are connected. And, a signal is selectively input in the signal line in the m -th row from the writing gate signal line driver circuit 913, and the first transistor is turned on, while signals for writing are input in the source signal lines in the first
15 column to the last column from the source signal line driver circuit 915. The light emitting element in the m -th row becomes light emitting or non-light emitting depending on these signals.

[0126]

Right after terminating the writing period in the m -th row as mentioned above,
20 it moves to the erasing period in the $m + 1$ -th row. Therefore, the gate signal line and the writing gate signal line driver circuit 913 are disconnected, while the source signal line is connected to the power source 916 by switching the switch 918. In addition, the gate signal line and the writing gate signal line driver circuit 913 are disconnected, while the gate signal line is in a connected state to the erasing gate signal line driver
25 circuit 914. And, a signal is selectively input in the gate signal line in the $n + 1$ -th row from the erasing gate signal line driver circuit 914 to turn the signal on to the first transistor, while an erasing signal is input from the power source 916. Right after terminating the erasing period in the $n + 1$ -th row in this manner, it moves to the writing period in the m -th row. Hereinafter, similarly, an erasing period and a writing period
30 may be repeated and operated up to the erasing period of the last row.

[0127]

Note that, in the present embodiment, although a mode in which the writing period in the m-th row is provided between the erasing period of the n-th row and the erasing period of the n + 1-th row is described, without limitation thereto, the writing period of the m-th row may be provided between the erasing period in the n - 1-th row and the erasing period in the n-th row.

[0128]

In addition, in the present embodiment, when the non-light emitting period 504d is provided as in the sub-frame 504, the operations of making the erasing gate signal line driver circuit 914 and one certain gate signal line to be in a disconnected state and making the writing gate signal line driver circuit 913 and another gate signal line to be in a connected state are repeated. Such operations may be performed in a frame in which a non-light emitting period is not particularly provided.

[0129]

(Embodiment 4)

One mode of a light emitting device including a light emitting element of the present invention is described with reference to cross-sectional views of FIG. 11.

[0130]

In FIG. 11, what is surrounded by a dashed line is a transistor 11 that is provided for driving a light emitting element 12 of the present invention. The light emitting element 12 is a light emitting element of the present invention that includes a layer 15, in which a hole generating layer, an electron generating layer, and a layer containing a light emitting substance are stacked, between a first electrode 13 and a second electrode 14. A drain of the transistor 11 and the first electrode 13 are electrically connected by a wiring 17 penetrating a first interlayer insulating film 16 (16a, 16b, 16c). In addition, the light emitting element 12 is isolated from another light emitting element provided adjacently by a partition wall layer 18. The light emitting device of the present invention having such a structure is provided over a substrate 10 in the present embodiment.

[0131]

Note that the transistor 11 shown in FIG. 11 is of a top-gate type in which a gate electrode is provided on an opposite side of the substrate with a semiconductor layer as a center. Note that, there is no particular limitation on the structure of the

transistor 11, for example, it may be of a bottom-gate type. In addition, in the case of the bottom-gate, it is acceptable whether one in which a protective film is formed over a semiconductor layer forming a channel (a channel protective type) or one in which a part of a semiconductor layer forming a channel has a depression shape (a channel etched type). Note that 21 is a gate electrode; 22, a gate insulating film; 23, a semiconductor layer; 24, an n-type semiconductor layer; 25, an electrode; 26, a protective film.

[0132]

In addition, the semiconductor layer included in the transistor 11 may be either crystalline or non-crystalline. Alternatively, it may be semiamorphous or the like.

[0133]

Note that, the semiamorphous semiconductor is the following. It has an intermediate structure between amorphous and a crystalline structure (including single crystal, polycrystal), is a semiconductor having a third state that is stable in terms of free energy, and includes a crystalline region having a short-range order and lattice distortion. In addition, a crystal grain of 0.5 ~ 20 nm is included in at least a part of a region in the film. Raman spectrum is shifted to lower wave number side than 520 cm^{-1} . The diffraction peaks of (111), (220), which are considered to be derived from Si crystal lattice, are observed by the X-ray diffraction. It contains hydrogen or a halogen of at least 1 atomic% or more for terminating dangling bonds (dangling bond). It is also referred to as a so-called microcrystalline semiconductor (microcrystal semiconductor). It is formed by glow discharge decomposition with a silicide gas (plasma CVD). As the silicide gas, SiH_4 , in addition, Si_2H_6 , SiH_2Cl_2 , SiHCl_3 , SiCl_4 , SiF_4 , or the like can be used. This silicide gas may also be diluted with H_2 , or H_2 and one kind or a plurality of kinds of rare gas elements selected from He, Ar, Kr, Ne. The dilution ratio is in the range of 2 ~ 1000 times. The pressure is approximately in the range of 0.1 Pa ~ 133 Pa. The power frequency is 1 MHz ~ 120 MHz, preferably, 13 MHz ~ 60 MHz. The substrate heating temperature may be 300 °C or less, preferably, 100 °C ~ 250 °C. As an impurity element in the film, the impurity in an atmospheric constituent such as oxygen, nitrogen, carbon is desirably set to $1 \times 10^{20}/\text{cm}^3$ or less. In particular, the oxygen concentration is $5 \times 10^{19}/\text{cm}^3$ or less, preferably, $1 \times 10^{19}/\text{cm}^3$ or

less. Note that, the mobility of a TFT (thin film transistor) using the semiconductor having an amorphous one is about $1 \sim 10 \text{ m}^2/\text{Vsec}$.

[0134]

- 5 In addition, as a specific example of a crystalline semiconductor layer, one made from single crystal or polycrystalline silicon, silicon germanium, or the like can be given. These may be formed by laser crystallization or may be formed by crystallization with use of a solid phase growth method using nickel or the like, for example.

[0135]

- 10 Note that when a semiconductor layer is formed from an amorphous substance, for example, amorphous silicon, a light emitting device including circuits all constituted by N-channel transistors for the transistor 11 and other transistors (transistors included in a circuit for driving a light emitting element) is preferable. Other than that, it may be a light emitting device including circuits constituted by either an N-channel or
15 P-channel transistor or may be a light emitting device including circuits constituted by both of the transistors.

[0136]

- Further, the first interlayer insulating film 16 may be a multilayer or a single layer as shown in FIGS. 11(A), (C). Note that 16a is made from an inorganic material
20 such as silicon oxide or silicon nitride, and 16b is made from acrylic, siloxane (a substance in which a skeletal structure is made from a bond of silicon (Si) and oxygen (O) and at least includes hydrogen in a substituent), or a substance having a self-planarizing property such as silicon oxide that can be applied to form a film. Further, 16c is made from a silicon nitride film containing argon (Ar). Note that there
25 is no particular limitation on the substances forming each layer, and one other than those mentioned here may also be used. Alternatively, a layer made from the substance other than these may be further combined. In this manner, the first interlayer insulating film 16 may be formed by using both an inorganic material or an organic material or may be formed by using either an inorganic film or an organic film.

- 30 [0137]

The edge portion of the partition wall layer 18 preferably has a shape in which the curvature radius is continuously changed. In addition, the partition wall layer 18 is

formed by using acrylic, siloxane, resist, silicon oxide, or the like. Note that, the partition wall layer 18 may be formed from either an inorganic film or an organic film, or may be formed by using both.

[0138]

5 Note that FIGS. 11(A), (C) show the structure in which only the first interlayer insulating film 16 is interposed between the transistor 11 and the light emitting element 12; however, as shown in FIG. 11(B), the structure may be such that in addition to the first interlayer insulating film 16 (16a, 16b), a second interlayer insulating film 19 (19a, 19b) is provided. In the light emitting device shown in FIG. 11(B), the first electrode
10 13 penetrates the second interlayer insulating film 19 to be connected to the wiring 17.

[0139]

The second interlayer insulating film 19 may be either a multilayer or a single layer, as with the first interlayer insulating film 16. 19a is made from acrylic, siloxane (a substance that has a skeletal structure made from a bond of silicon (Si) and oxygen
15 (O) and includes at least hydrogen in a substituent), or a substance having a self-planarizing property such as silicon oxide that can be applied to form a film. Further, 19b is made from a silicon nitride film containing argon (Ar). Note that there is no particular limitation on the substances included in each layer, and one other than those mentioned here may also be used. Alternatively, a layer with a substance other
20 than these may be further combined. In this manner, the second interlayer insulating film 19 may be formed by using both an inorganic material or an organic material or may be formed from either an organic film or an inorganic film.

[0140]

In the light emitting element 12, when the first electrode and the second
25 electrode are both made from a substance with a light-transmitting property, light emission can be extracted through both the first electrode 13 side and the second electrode 14 side as shown in the open arrows of FIG. 11(A). In addition, when only the second electrode 14 is made from a substance having a light-transmitting property, light emission can be extracted only through the second electrode 14 side as shown in
30 the open arrow of FIG. 11(B). In this case, the first electrode 13 is preferably made from a material with high reflectivity, or a film (reflective film) made from a material with high reflectivity is preferably provided under the first electrode 13. In addition,

when only the first electrode 13 is made from a substance having a light-transmitting property, light emission can be extracted only through the first electrode 13 side as shown in the open arrow of FIG. 11(C). In this case, the second electrode 14 is preferably made from a material with high reflectivity, or a reflective film is preferably provided over the second electrode 14.

[0141]

In addition, the light emitting element 12 may be such that the layer 15 is stacked so as to operate when voltage is applied so that potential of the second electrode 14 is higher than potential of the first electrode 13, or such that the layer 15 is stacked so as to operate when voltage is applied so that potential of the second electrode 14 is lower than potential of the first electrode 13. In the former case, the transistor 11 is an N-channel transistor. In the latter case, the transistor 11 is a P-channel transistor.

[0142]

As described above, an active light emitting device controlling driving of a light emitting element with a transistor is described in the present embodiment. Alternatively, it may be a passive light emitting device for driving a light emitting element without particularly providing an element for driving such as a transistor. In FIG. 12, a perspective view of an example of the passive light emitting device manufactured using the present invention is shown. In FIG. 12, a layer 955, in which a layer containing a light emitting substance and an electron generating layer, a hole generating layer are sequentially stacked, is provided between an electrode 952 and an electrode 956 over a substrate 951. An end portion of the electrode 952 is covered with an insulating layer 953. And, over the insulating layer 953, a partition wall layer 954 is provided. Sidewalls of the partition wall layer 954 has a slope such that the distance between one sidewall and other sidewall becomes narrower toward a surface of the substrate. In other words, a cross section of the partition wall layer 954 in a narrow side direction is a trapezoid shape having a shorter base side (a side in the same direction as a surface direction of the insulating layer 953 and contacting with the insulating layer 953) than an upper side (a side in the same direction as a surface direction of the insulating layer 953 and not contacting with the insulating layer 953). In this manner, by providing the partition wall layer 954, a defect of a light emitting element due to static electricity or the like can be prevented.

Note that the one shown in FIG. 12 is an example of a passive light emitting device, and there is no limitation to this structure.

In addition, a passive light emitting device can also be driven with small power consumption by including a light emitting element of the present invention which
5 operates with low driving voltage.

[0143]

(Embodiment 5)

The light emitting device using the light emitting element of the present invention as a pixel favorably operates displaying with a few display defects due to a malfunction of the light emitting element. Therefore, by applying such a light emitting
10 device to a display portion, an electronic device can be obtained with a few display image errors or the like due to the display defects. In addition, the light emitting device using the light emitting element of the present invention as a light source can favorably perform lighting with a few defects due to the malfunction of the light
15 emitting element. Therefore, by using such a light emitting device as a lighting portion such as a backlight and mounting the light emitting device of the present invention in this manner, the malfunctions in which a dark part is locally formed due to a defect of the light emitting element is decreased, and display can be performed favorably.

20 [0144]

FIG. 13 shows examples of the electronic devices on which light emitting devices using the present invention are mounted.

[0145]

FIG. 13(A) is a personal computer manufactured by using the present invention, including a main body 5521, a chassis 5522, a display portion 5523, a keyboard 5524,
25 and the like. The personal computer can be completed by incorporating the light emitting device shown in FIG. 7, which uses the light emitting element of the present invention as a pixel, as a display portion. Alternatively, the personal computer can be completed by incorporating the light emitting device, which uses the light emitting
30 element of the present invention as a light source, as a backlight.

[0146]

Specifically, as shown in FIG. 14, a lighting device in which a liquid crystal

device 5512 and a light emitting device 5513 are interposed between a chassis 5511 and a chassis 5514 may be incorporated as a display portion. Note that in FIG. 14, an external input terminal 5515 is attached in the liquid crystal device 5512, and the light emitting device 5513 includes a light emitting element array 5516 using the light emitting element of the present invention, and a light guide plate 5517. In the light emitting element array 5516, one line or a plurality of lines of the light emitting element of the present invention are formed. By the light guide plate, the structure is such that light emitted from the light emitting element array 5516 is emitted from an entire surface of the light guide plate, which is on a side facing the liquid crystal device 5512, toward the liquid crystal device 5512 side.

[0147]

Note that the light emitting device 5513 shown in FIG. 14 has a structure including the light emitting element array and the light guide plate; however, there is no limitation to this structure. For example, the structure may be such that, without providing the light guide plate, the light emitting element of the present invention is formed over a larger area and light emitted from the light emitting element is emitted directly toward the liquid crystal device 5512 without using the light guide plate.

[0148]

FIG. 13(B) is a telephone manufactured by using the present invention including a main body 5552 having a display portion 5551, a voice output portion 5554, a voice input portion 5555, operation switches 5556, 5557, an antenna 5553, and the like. The telephone can be completed by incorporating the light emitting device, including the light emitting element of the present invention, as a display portion.

[0149]

FIG. 13(C) is a television set manufactured by using the present invention, including a display portion 5531, a chassis 5532, a speaker 5533, and the like. By incorporating the light emitting device, including the light emitting element of the present invention, as a display portion, the television set can be completed.

[0150]

As described above, the light emitting device of the present invention is very suitable to be used for display portions of various electronic devices. Note that the electronic device is not limited to those described in the present embodiment, and may

be a navigation system or other electronic devices.

[0151]

In addition, among the above electronic devices, only the personal computer is described as an example of the light emitting device using the light emitting element of the invention as a light source, incorporated as a backlight; however, this is not limited to a personal computer, and any electronic device can use the light emitting element of the present invention as a light source as long as the backlight is used in the electronic device.

[0152]

10 [Example 1]

A carbazole derivative used in the light emitting element of the present invention has the structure represented by above mentioned General Formula (1). For R_1 , specifically, hydrogen; a halogen element such as fluorine or chlorine; a cyano group; an alkyl group such as a methyl group, an ethyl group, an isopropyl group, a cyclohexyl group; a haloalkyl group such as a trifluoromethyl group; an alkoxy group such as a methoxy group, an ethoxy group, an isopropoxy group, a cyclohexyloxy group; an aryl group such as a phenyl group, a naphthyl group, an anthryl group; a heterocycle residue such as an imidazolyl group, an oxathioly group, a thiazolyl group; or the like can be given. $R_2 \sim R_5$ may each be the same or different, and specifically, hydrogen; a halogen element such as fluorine or chlorine; a cyano group; an alkyl group such as a methyl group, an ethyl group, an isopropyl group, a cyclohexyl group; an alkoxy group such as a methoxy group, an ethoxy group, an isopropoxy group, a cyclohexyloxy group; an acyl group such as an acetyl group, an acrolyl group, a malonyl group, a benzoyl group, or a naphthoyl group; a haloalkyl group such as a trifluoromethyl group; a dialkylamino group such as a dimethylamino group, a diethylamino group, a diisopropylamino group; a diarylamino group such as a diphenylamino group or a carbazolyl group; a heterocycle residue such as an imidazolyl group, an oxathioly group, a thiazolyl group; or the like can be given. Although the specific examples of $R_1 \sim R_5$ are given, $R_1 \sim R_5$ are not limited to these.

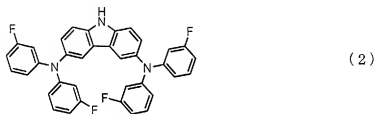
30 [0153]

In addition, as specific examples of the carbazole derivative used in the present

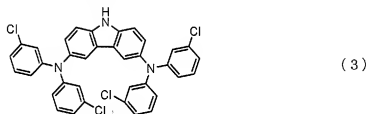
invention, by properly changing the structure of $R_1 \sim R_5$ in General Formula (1), for example, carbazole derivatives or the like shown in the following structural formulas (2) ~ (76) can be given. Note that the carbazole derivative used in the present invention is not limited to these.

5 [0154]

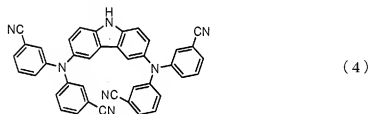
[Chemical Formula 2]



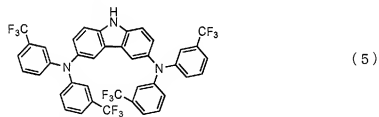
[Chemical Formula 3]



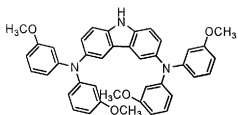
10 [Chemical Formula 4]



[Chemical Formula 5]

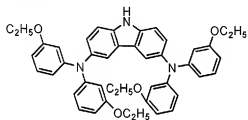


[Chemical Formula 6]



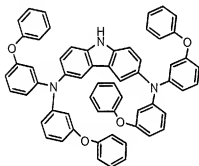
(6)

[Chemical Formula 7]



(7)

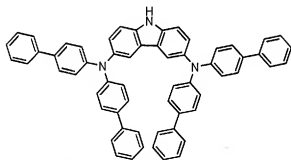
[Chemical Formula 8]



(8)

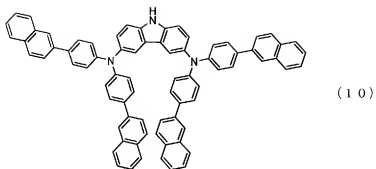
5

[Chemical Formula 9]

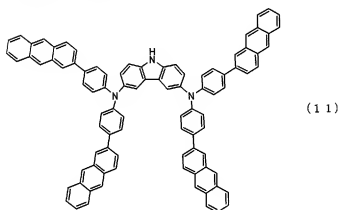


(9)

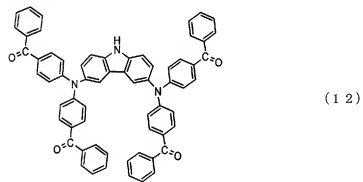
[Chemical Formula 10]



[Chemical Formula 11]

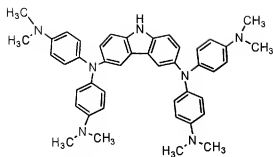


[Chemical Formula 12]



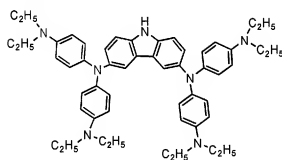
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[Chemical Formula 13]



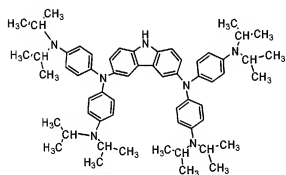
(1 3)

[Chemical Formula 14]



(1 4)

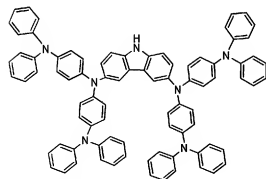
[Chemical Formula 15]



(1 5)

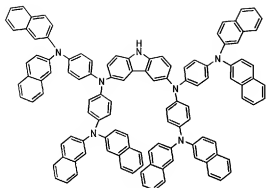
5

[Chemical Formula 16]



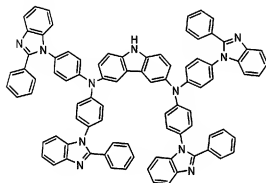
(1 6)

[Chemical Formula 17]



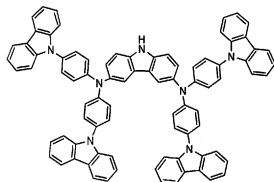
(1 7)

[Chemical Formula 18]



(1 8)

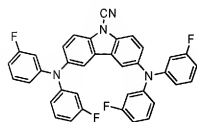
[Chemical Formula 19]



(1 9)

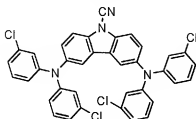
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[Chemical Formula 20]



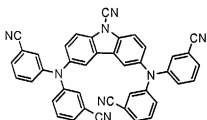
(2 0)

[Chemical Formula 21]



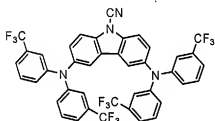
(2 1)

[Chemical Formula 22]



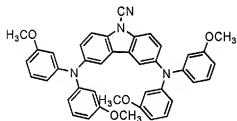
(2 2)

5 [Chemical Formula 23]



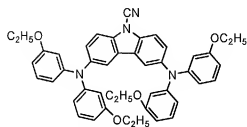
(2 3)

[Chemical Formula 24]



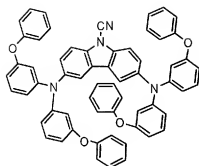
(2 4)

[Chemical Formula 25]



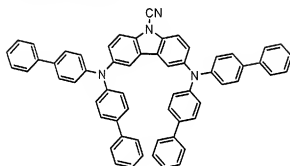
(2 5)

[Chemical Formula 26]



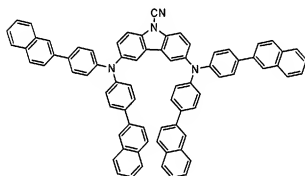
(2 6)

[Chemical Formula 27]



(2 7)

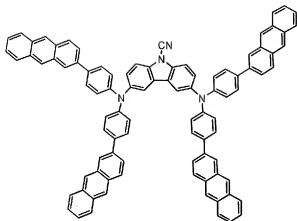
[Chemical Formula 28]



(2 8)

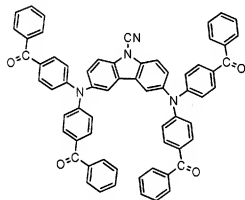
5

[Chemical Formula 29]



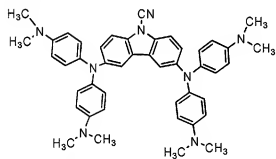
(2 9)

[Chemical Formula 30]



(3 0)

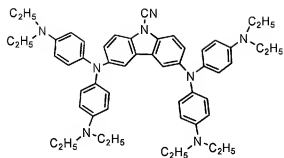
[Chemical Formula 31]



(3 1)

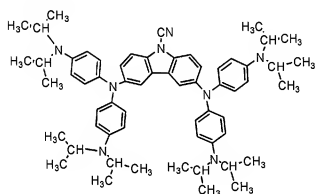
5

[Chemical Formula 32]



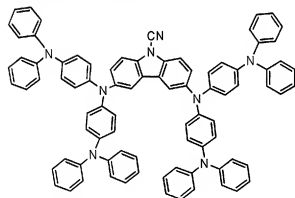
(3 2)

[Chemical Formula 33]



(3 3)

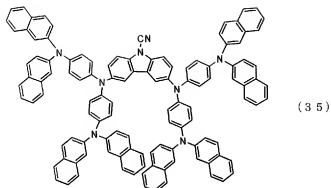
[Chemical Formula 34]



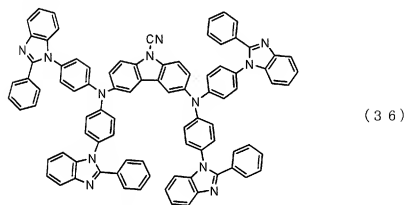
(3 4)

5

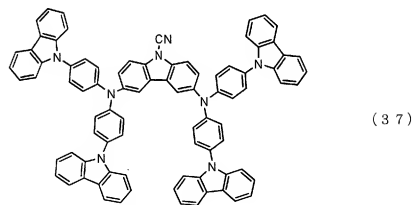
[Chemical Formula 35]



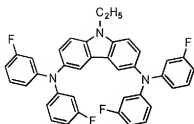
[Chemical Formula 36]



[Chemical Formula 37]

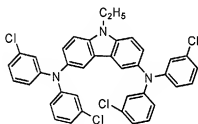


[Chemical Formula 38]



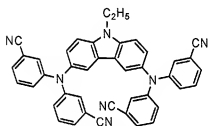
(3 8)

[Chemical Formula 39]



(3 9)

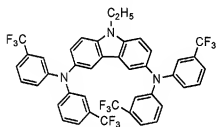
[Chemical Formula 40]



(4 0)

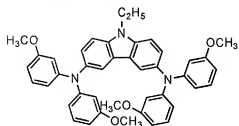
5

[Chemical Formula 41]



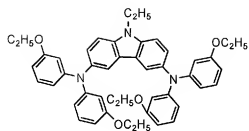
(4 1)

[Chemical Formula 42]



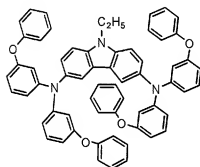
(4 2)

10 [Chemical Formula 43]



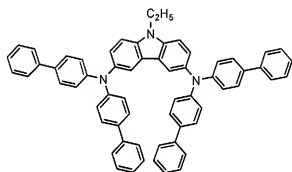
(4 3)

[Chemical Formula 44]



(4 4)

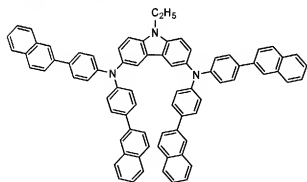
[Chemical Formula 45]



(4 5)

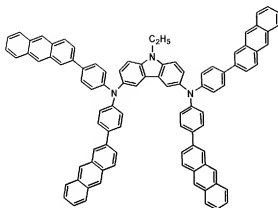
5

[Chemical Formula 46]



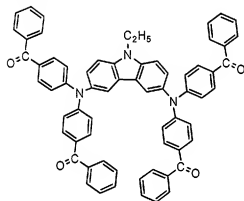
(4 6)

[Chemical Formula 47]



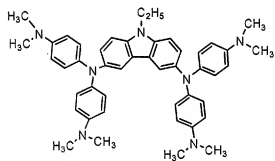
(4 7)

[Chemical Formula 48]



(4 8)

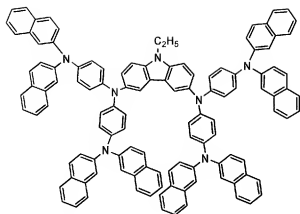
[Chemical Formula 49]



(4 9)

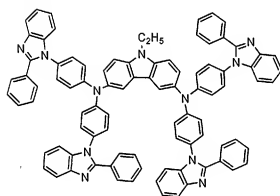
5

[Chemical Formula 50]



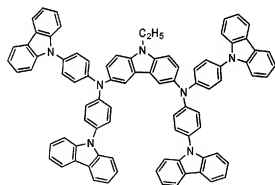
(5 3)

[Chemical Formula 54]



(5 4)

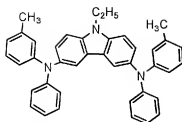
[Chemical Formula 55]



(5 5)

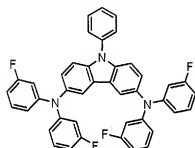
5

[Chemical Formula 56]



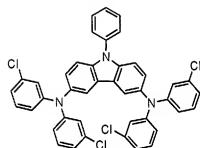
(5 6)

[Chemical Formula 57]



(5 7)

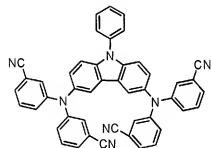
[Chemical Formula 58]



(5 8)

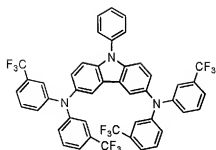
5

[Chemical Formula 59]



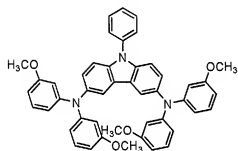
(5 9)

[Chemical Formula 60]



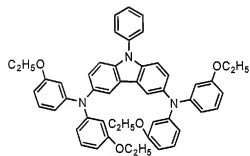
(6 0)

[Chemical Formula 61]



(6 1)

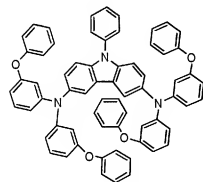
[Chemical Formula 62]



(6 2)

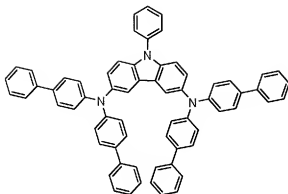
5

[Chemical Formula 63]



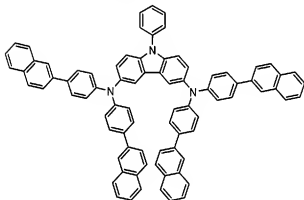
(6 3)

[Chemical Formula 64]



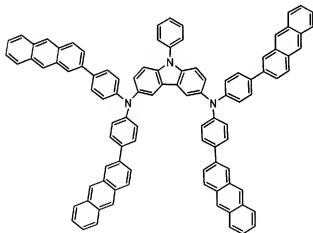
(6 4)

[Chemical Formula 65]



(6 5)

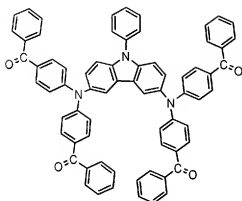
[Chemical Formula 66]



(6 6)

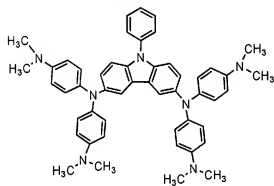
5

[Chemical Formula 67]



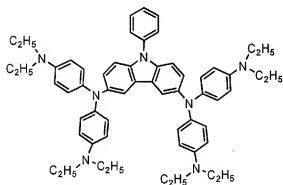
(6 7)

[Chemical Formula 68]



(6 8)

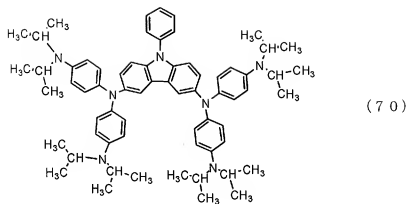
[Chemical Formula 69]



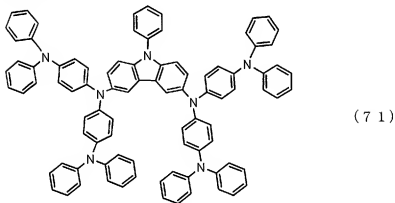
(6 9)

5

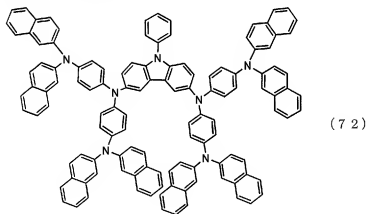
[Chemical Formula 70]



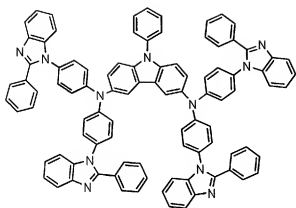
[Chemical Formula 71]



[Chemical Formula 72]

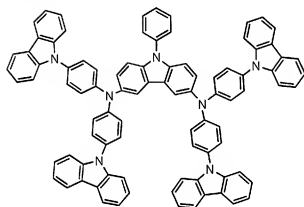


[Chemical Formula 73]



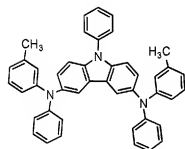
(7 3)

[Chemical Formula 74]



(7 4)

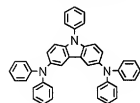
[Chemical Formula 75]



(7 5)

5

[Chemical Formula 76]



(7 6)

[Example 2]

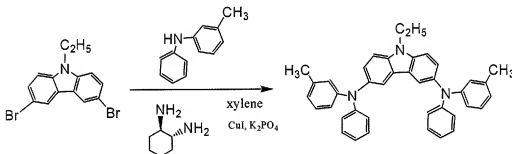
[0155]

In Example 1, a plurality of specific examples of the carbazole derivative used in the present invention is shown, and various reactions can be applied as a synthetic method of the carbazole derivative used in the present invention.

In the present example, a synthetic example of the carbazole derivative shown in the above structural formula (56), which is one example of the carbazole derivative used in the present invention, is specifically exemplified. Note that the synthetic method of the carbazole derivative shown in the above structural formula (56) used in the present invention is not limited to this. Note that a synthetic scheme of the synthetic example of the carbazole derivative represented by the above structure (56) described in the present example is shown below.

[0156]

[Chemical Formula 77]



[0157]

In an argon atmosphere, 16.59 g (30 mmol) of N-ethyl-3,6-dibromocarbazole and 12.09 g (66 mmol) of N-(3-methylphenyl)-N-phenylamine were dissolved in 100 ml of dehydrated xylene. To this, 5.7 g (30 mmol) of copper iodide and 22.8 g (200 mmol) of trans-cyclohexanediamine were added, and were stirred at 160 °C for 30 minutes. After the stirring was finished, 27.6 g (130 mmol) of potassium phosphate was added, and was further stirred for 9 days. After the stirring is finished, it was returned to a room temperature, 300 ml of toluene was added, and a precipitate was filtered out. The obtained filtrate was condensed, diethyl ether was added to this, and a precipitate was filtered out. When methanol was added to the obtained filtrate, a tarry

object was precipitated on a wall surface of a beaker. This was left at rest overnight, and the liquid phase was removed by decantation to obtain the tarry object. This obtained tarry object was subjected to silica gel column purification with hexane:chloroform (1:2) to obtain 3,6-bis[N-(3-methylphenyl)-N-phenylamino]-9-ethylcarbazole (the above structural formula (56); hereinafter, referred to as EtCzmP2) that is light brownish green powder. The obtained EtCzmP2 was purified by sublimation at a high temperature set at 300 °C and a low temperature of 200 °C. The yield after the sublimation purification was approximately 10 %.

10 [0158]

Note that, according to a thermogravimetry-differential thermal analysis (TG-DTA) measurement, it was found that the decomposition temperature of the obtained EtCzmP2 was 310 °C. When vacuum evaporation method was used for deposition, it was possible to form a uniform film.

15 [0159]

Note that, when fluorescence spectra of a thin film and a solution (solvent: methanol) of EtCzmP2 were measured, the fluorescence spectra which had a maximum peak at 435 nm with respect to an excitation wavelength (312 nm) in the case of the thin film and a maximum peak at 400 nm with respect to an excitation wavelength (290 nm) in the case of the solution were obtained (FIG 15). In addition, when UV-Vis region absorption spectra of the thin film and solution (solvent: methanol) of EtCzmP2 were measured, maximum absorption wavelengths were obtained at 312 nm in the case of the thin film and at 303 nm in the case of the solution (FIG 16).

[0160]

25 Further, the value of a HOMO level that was measured by using Photoelectron Spectrometer AC-2 (manufactured by Riken Keiki Co., Ltd.) was -5.18 eV. In addition, the value of a LUMO level that was estimated by adding the value of an absorption edge of the absorption spectrum (FIG. 16), as an energy gap, to the value of the HOMO level was -1.71 eV.

30 [Example 3]

[0161]

In the present example, a synthetic example of the carbazole derivative shown in the above-mentioned structural formula (75), which is one example of the carbazole derivative used in the present invention, is specifically exemplified.

[0162]

- 5 In the present synthesis example 2, a raw material, 12.03 g (30 mmol) of N-phenyl-3,6-dibromocarbazole was used to obtain 3,6-bis[N-(3-methylphenyl)-N-phenylamino]-9-phenylcarbazole (the above structural formula (75); hereinafter, referred to as PhCzmP2), that is the carbazole derivative of the present invention, in the same way as in the above synthesis example 1. The
10 obtained PhCzmP2 was purified by sublimation at a high temperature set at 290 °C and a low temperature of 90 °C. The yield after the sublimation purification was approximately 10 %.

[0163]

- FIG. 17 shows a ^1H NMR spectrum of the obtained PhCzmP2, and FIG. 18
15 shows an enlarged view of a region surrounded by a dashed line (A) in FIG. 17. In FIGS. 17, 18, a longitudinal axis indicates relative intensity of signals, and a lateral axis indicates the dimensionless value δ , which is the difference of resonant frequency between a sample and a reference sample divided by frequency of an oscillator.

[0164]

- 20 Data of the ^1H NMR of the obtained PhCzmP2 are as follows:
 ^1H NMR (300 MHz, DMSO-d) ; δ = 3.31 (s, 6H), 6.74 (s, 2H), 6.75 (d, j = 6.0, 4H), 6.85-6.91 (m, 6H), 7.08 (t, j = 7.8, 2H), 7.15-7.20 (m, 6H), 7.33 (d, j = 8.7, 2H), 7.51 (t, j = 7.2, 1H), 7.58-7.68 (m, 4H), 7.91 (s, 2H).

[0165]

- 25 Note that it was found that the decomposition temperature of the obtained PhCzmP2 was 230 °C. When vacuum evaporation method was used for deposition, it was possible to form a uniform film.

[0166]

- Note that when fluorescence spectra of a thin film and solution (solvent:
30 methanol) of PhCzmP2 were measured, the fluorescence spectra which had a maximum peak at 430 nm with respect to an excitation wavelength (308 nm) in the case of the thin

film and a maximum peak at 439 nm with respect to an excitation wavelength (320 nm) in the case of the solution were obtained (FIG. 19). In addition, when an UV-Vis region absorption spectrum of the thin film of PhCzmP2 was measured, a maximum absorption wavelength of 308 nm was obtained (FIG. 20).

5 [0167]

Further, the value of a HOMO level that was measured in the same way as in the above synthesis example 1 was -5.40 eV and the value of a LUMO level was -2.39 eV.

[Example 4]

10 [0168]

In the present example, a synthetic example of the carbazole derivative shown in the above-mentioned structural formula (76), which is one example of the carbazole derivative used in the present invention, is specifically exemplified.

[0169]

15 In the present synthesis example 3, raw materials, 12.03 g (30 mmol) of N-phenyl-3,6-dibromocarbazole and diphenylamine (12.18 g, 72 mmol) were used to obtain N-phenyl-3,6-di-diphenylaminocarbazole (the above structural formula (76); hereinafter, referred to as PhCzP2), that is the carbazole derivative of the present invention in the same way as in the above synthesis example 1. The obtained PhCzP2
20 was purified by sublimation at a high temperature set at 270 °C and a low temperature of 175 °C. The yield after the sublimation purification was approximately 50 %.

FIG. 21 shows a ^1H NMR spectrum of the obtained PhCzP2, FIG. 22 shows a ^{13}C NMR spectrum, and FIG. 23 shows an enlarged view of a region surrounded by a dashed line (A) in FIG. 22. In FIGS. 21 ~ 23, a longitudinal axis indicates relative intensity of signals, and a lateral axis indicates the dimensionless value δ which is the difference of resonant frequency between a sample and an authentic sample divided by frequency of an oscillator.

25 Data of ^1H NMR of the obtained PhCzP2 are as follows:

^1H NMR (300 MHz, DMSO-d); δ = 6.88-6.95 (m, 12H), 7.17-7.23 (m, 10H), 7.35 (d, j
30 = 4.5, 6H), 7.56-7.69 (m, 5H), 7.97 (s, 2H)

^{13}C NMR (75 MHz, DMSO-d); δ = 111.1, 119.4, 121.6, 122.0, 123.6, 126.4, 126.8,

127.8, 129.3, 130.2, 136.7, 138.2, 139.9, 148.0.

[0170]

- Note that, according to a TG-DTA measurement, it was found that the decomposition temperature of the obtained PhCzP2 was 365 °C. When vacuum evaporation method was used for deposition, it was possible to form a uniform film.

[0171]

- Note that, when fluorescence spectra of a thin film and a solution (solvent: dichloromethane) of PhCzP2 were measured, the fluorescence spectra which had a maximum peak at 429 nm with respect to an excitation wavelength (313 nm) in the case of the thin film and a maximum peak at 435 nm with respect to an excitation wavelength (315 nm) in the case of the solution were obtained (FIG. 24). In addition, when UV-Vis region absorption spectra of the thin film and dichloromethane solution of PhCzP2 were measured, maximum absorption wavelengths were obtained at 313 nm in the case of the thin film and at 305 nm in the case of the solution (FIG. 25).

15 [0172]

Further, the value of a HOMO level that was measured in the same way as in the above synthesis example 1 was -5.31 eV and the value of a LUMO level was -2.57 eV.

[Brief Description of the Drawings]

20 [0173]

[FIG. 1] A drawing for explaining one mode of a light emitting element of the present invention.

[FIG. 2] A drawing for explaining one mode of a light emitting element of the present invention.

- 25 [FIG. 3] A drawing for explaining one mode of a light emitting element of the present invention.

[FIG. 4] A drawing for explaining one mode of a light emitting element of the present invention.

- 30 [FIG. 5] A drawing for explaining one mode of a light emitting element of the present invention.

[FIG. 6] A drawing for explaining one mode of a light emitting element of the

present invention.

[FIG. 7] A top view for explaining one mode of a light emitting device of the present invention.

[FIG. 8] A drawing for explaining one mode of a circuit for driving a pixel
5 provided in a light emitting device of the present invention.

[FIG. 9] A drawing for explaining one mode of a pixel portion included in a light emitting device of the present invention.

[FIG. 10] A frame diagram for explaining a method for driving a pixel included in a light emitting device of the present invention.

[FIG. 11] Drawings for explaining modes of cross-sections of light emitting
10 devices of the present invention.

[FIG. 12] A drawing for explaining one mode of a light emitting device of the present invention.

[FIG. 13] Drawings for explaining modes of electronic devices using the
15 present invention.

[FIG. 14] A graph for explaining a lighting device using the present invention.

[FIG. 15] A graph showing fluorescence spectra of a carbazole derivative used in the present invention.

[FIG. 16] A graph showing UV-Vis absorption spectra of a carbazole derivative
20 used in the present invention.

[FIG. 17] A graph showing a ^1H NMR spectrum of a carbazole derivative used in the present invention.

[FIG. 18] An enlarged view of a ^1H NMR spectrum of a carbazole derivative used in the present invention.

[FIG. 19] A graph showing fluorescence spectra of a carbazole derivative used in the present invention.

[FIG. 20] A graph showing UV-Vis absorption spectrum of a carbazole derivative used in the present invention.

[FIG. 21] A graph showing a ^1H NMR spectrum of a carbazole derivative used
30 in the present invention.

[FIG. 22] A graph showing a ^{13}C NMR spectrum of a carbazole derivative used in the present invention.

[FIG. 23] An enlarged view of a ^{13}C NMR spectrum of a carbazole derivative used in the present invention.

[FIG. 24] A graph showing fluorescence spectra of a carbazole derivative used in the present invention.

5 [FIG. 25] A graph showing UV-Vis absorption spectra of a carbazole derivative used in the present invention.

[Description of the Numerals]

[0174]

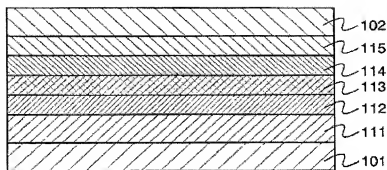
101: first electrode, 102: second electrode, 111: hole generating layer, 112: hole
 10 transport layer, 113: light emitting layer, 114: electron transport layer, 115: electron
 generating layer, 116: electron injection layer, 117: hole blocking layer, 201: first
 electrode, 202: second electrode, 211: first layer, 212: second layer, 213: third layer,
 221: electron transport layer, 222: light emitting layer, 223: hole transport layer, 224:
 hole generating layer, 225: hole injection layer, 226: hole blocking layer, 6500: substrate,
 15 6503: FPC, 6504: printed wiring board, 6511: pixel portion, 6512: source signal line
 driver circuit, 6513: writing gate signal line driver circuit, 6514: erasing gate signal line
 driver circuit, 901: transistor, 902: transistor, 903: light emitting element, 911: gate
 signal line, 912: source signal line, 913: writing gate signal line driver circuit, 914:
 erasing gate signal line driver circuit, 915: source signal line driver circuit, 916: power
 20 source, 917: current supply line, 918: switch, 919: switch, 920: switch, 1001: transistor,
 1002: transistor, 1003: gate signal line, 1004: source signal line, 1005: current supply
 line, 1006: electrode, 501: sub-frame, 502: sub-frame, 503: sub-frame, 504: sub-frame,
 501a: writing period, 501b: holding period, 502a: writing period, 502b: holding period,
 503a: writing period, 503b: holding period, 504a: writing period, 504b: holding period,
 25 504c: erasing period, 504d: non-light emitting period, 10: substrate, 11: transistor, 12:
 light emitting element, 13: first electrode, 14: second electrode, 15: layer, 16: interlayer
 insulating film, 17: wiring, 18: partition wall layer, 19: interlayer insulating film, 951:
 substrate, 952: electrode, 956: electrode, 955: layer, 953: insulating layer, 954: partition
 wall layer, 953: insulating layer, 5521: main body, 5522: chassis, 5523: display portion,
 30 5524: keyboard, 5511: chassis, 5512: liquid crystal device, 5513: light emitting device,
 5514: chassis, 5515: external input terminal, 5516: light emitting element array, 5551:
 display portion, 5552: main body, 5553: antenna, 5554: voice output portion, 5555:

voice input portion, 5556: operation switch, 5531: display portion, 5532: chassis, 5533: speaker.

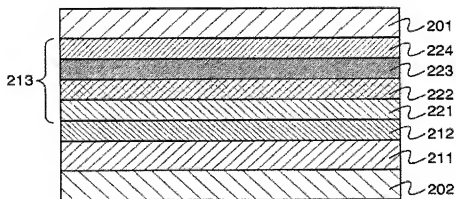
[Document Name]

Drawings

[FIG. 1]

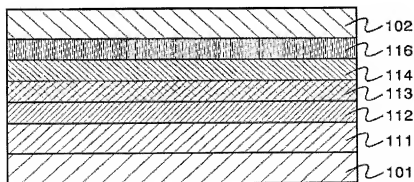


[FIG. 2]

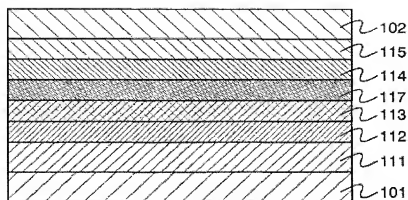


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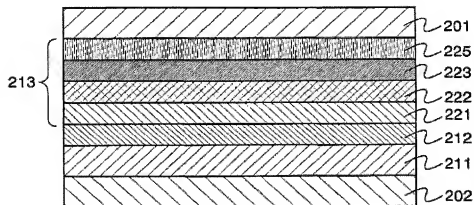
[FIG. 3]



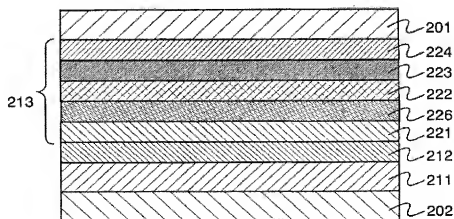
[FIG. 4]



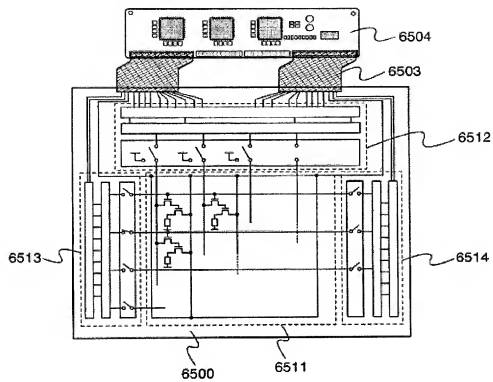
[FIG. 5]



5 [FIG. 6]



[FIG. 7]

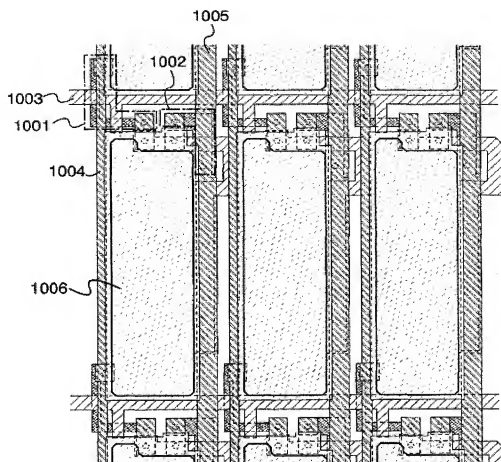


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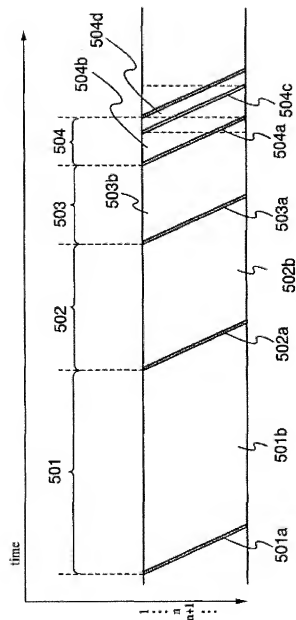
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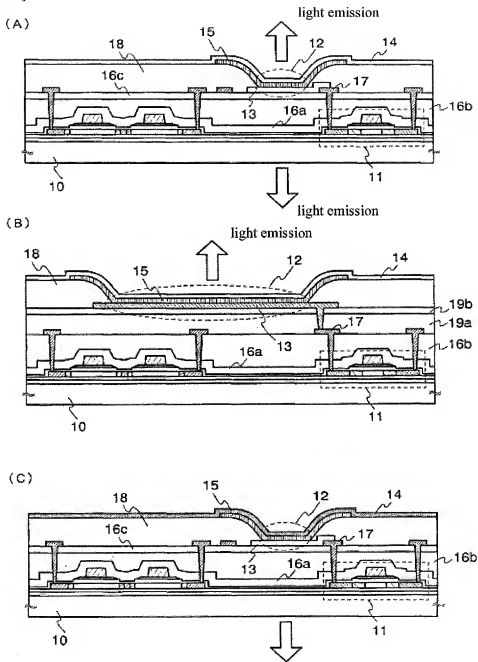
[FIG. 9]



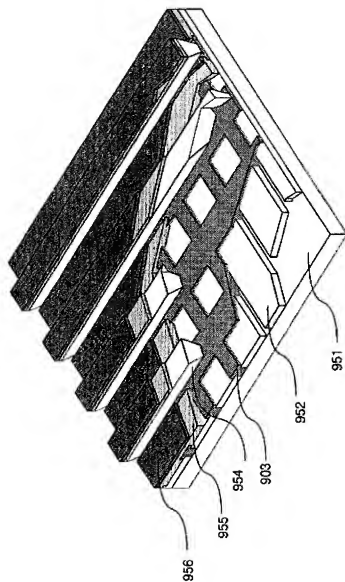
[FIG. 10]



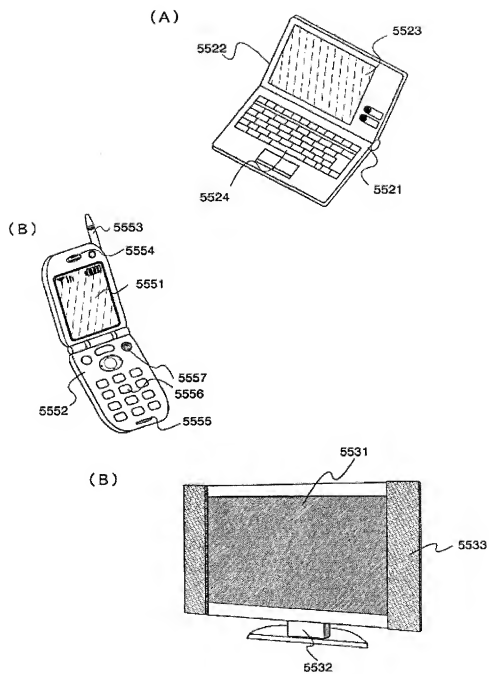
[FIG. 11]



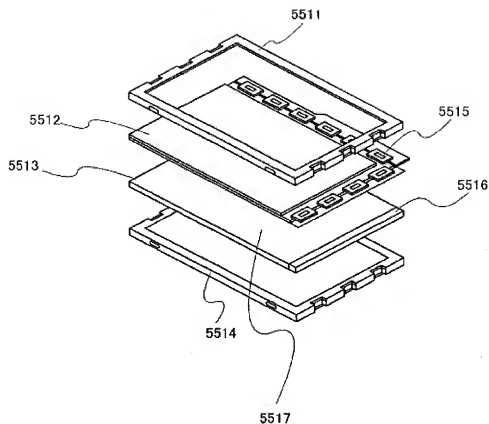
[FIG. 12]



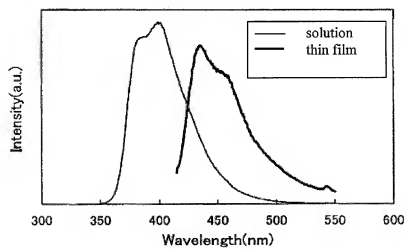
[FIG. 13]



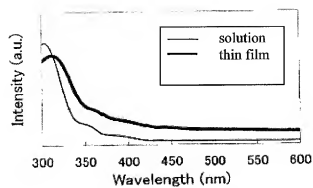
[FIG. 14]



[FIG. 15]



[FIG 16]



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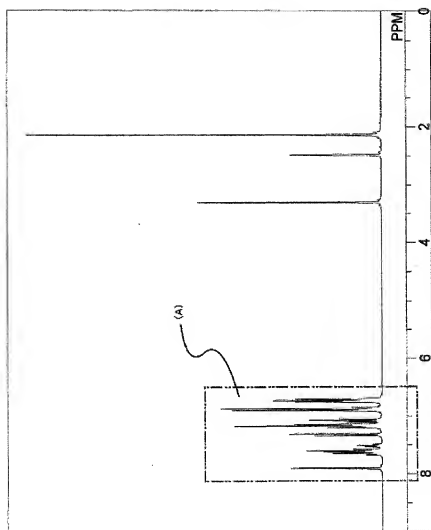
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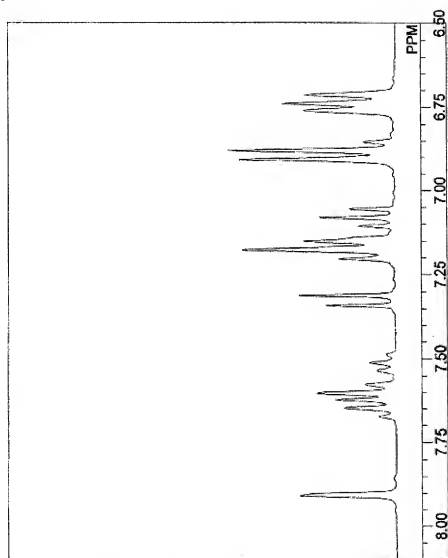
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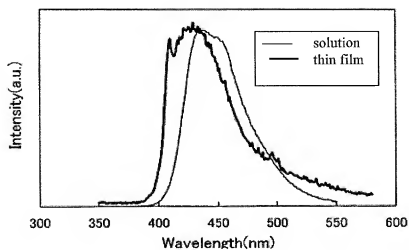
[FIG. 17]



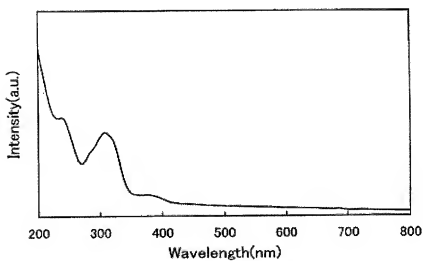
[FIG. 18]



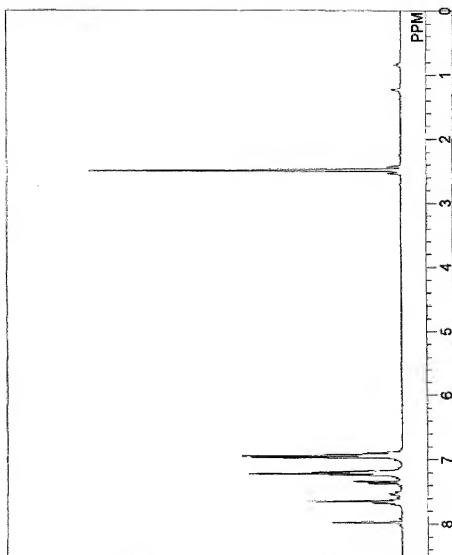
[FIG. 19]



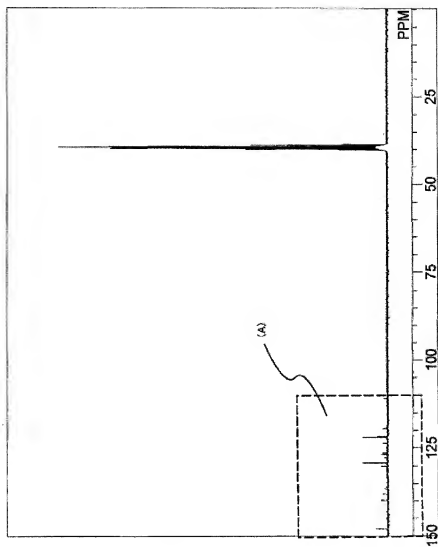
[FIG. 20]



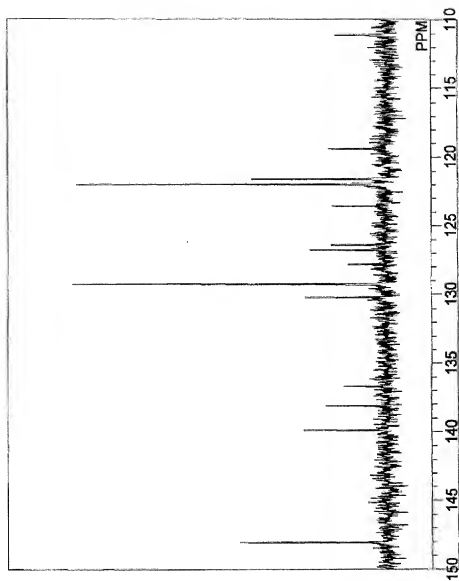
[FIG. 21]



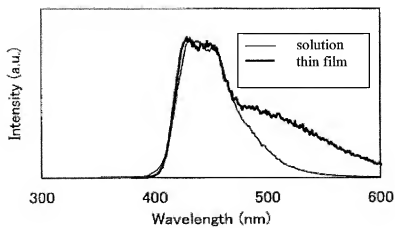
[FIG. 22]



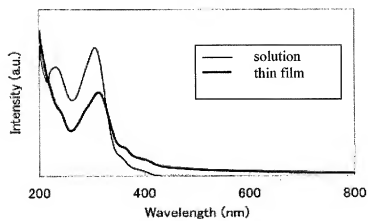
[FIG. 23]



[FIG. 24]



[FIG. 25]



[Document Name] Abstract

[Abstract]

[Problem] An object of the present invention is to provide a light emitting element which has low driving voltage and can increase lifetime longer than a
5 conventional light emitting element.

[Solving Means] One feature is to include a plurality of layers which includes a layer containing a light emitting substance between a first electrode and a second electrode, in which at least one layer of the plurality of layers contains a carbazole derivative represented by General Formula (1) and a substance having an electron
10 accepting property with respect to the carbazole derivative represented by General Formula (1). By employing such a structure, the above object can be achieved.

[Selected Drawing] FIG. 1

[Document Name] Amendment
 [Reference Number] P008363
 [Filing Date] 5 April, 2005
 [Attention] Commissioner, Patent Office

5 [Case Indication]

[Application Number] Japanese Patent Application No. JP2004-347903

[Amending Person]

[Identification Number] 000153878

[Name] Semiconductor Energy Laboratory Co., Ltd.

10 [Representative] Shunpei YAMAZAKI

[Amendment 1]

[Document Name of Object for Amendment] Patent Application

[Item Name of Object for Amendment] Inventor

[Amendment Method] change

15 [Contents of Amendment]

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[Others] An inventor of the invention according to this patent application is
"Ryoji NOMURA"; however, the application procedure was performed while a Chinese
character for "ji" was mistyped as a Katakana "ni". With this amendment, the inventor
15 is amended as "Ryoji NOMURA".

Applicant Record

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19900817

5 New Registration

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